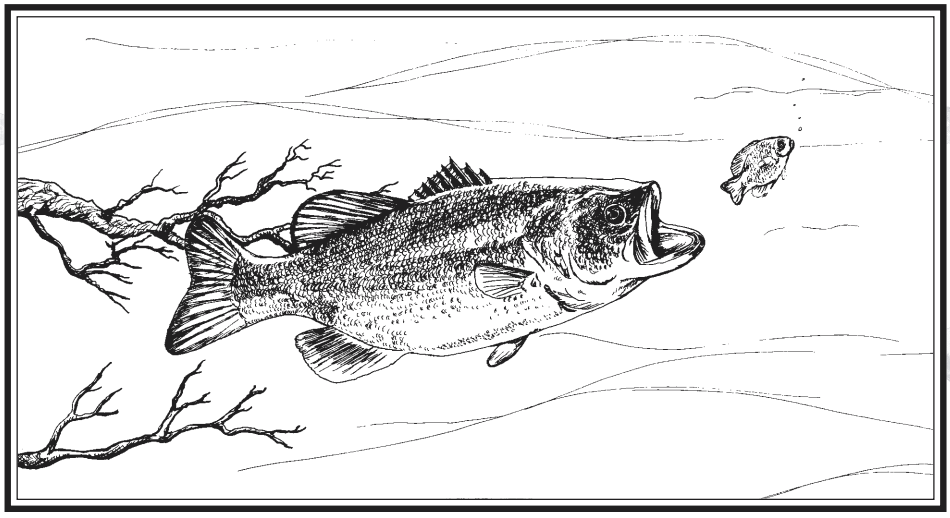
TESTING



THE WATERS

Lake Norman State Park

An Environmental Education Learning Experience

Designed for Grades 4-8

"Earth is home to us all.
Water is life to us all.
Share it responsibly."

– North Carolina
Wildlife Resources Commission

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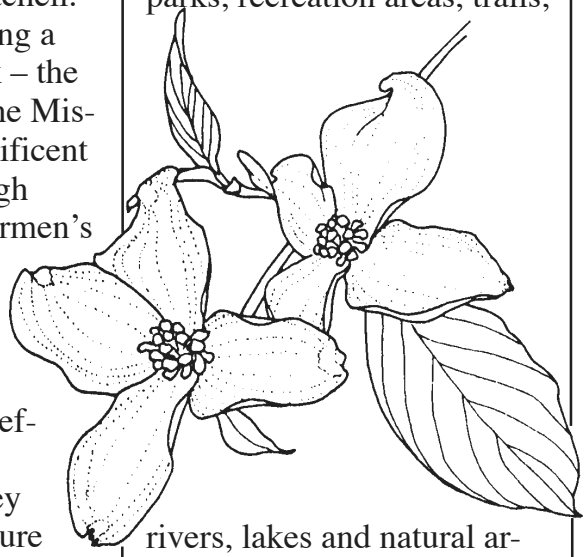
Table of Contents

Introduction to the North Carolina State Parks System

Preserving and protecting North Carolina's natural resources is actually a relatively new idea. The seeds of the conservation movement were planted early in the 20th century when citizens were alerted to the devastation of Mount Mitchell. Logging was destroying a well-known landmark – the highest peak east of the Mississippi. As the magnificent forests of this mile-high peak fell to the lumbermen's axe, alarmed citizens began to voice their opinions. Governor Locke Craig joined these citizens in their efforts to save Mount Mitchell. Together they convinced the legislature to pass a bill establishing Mount Mitchell as the first state park. That was in 1915.

The North Carolina state parks system has now been established for more than three quarters of a century. What started out as one small plot of public land has grown into 61 properties across the state, including parks, recreation areas, trails, rivers, lakes and natural areas. This vast network of land boasts some of the most beautiful scenery in the world and offers endless recreational opportunities. But our state parks system offers much more than scenery and recreation. Our lands and waters contain unique and valuable archaeological, geological and biological resources that are important parts of our natural heritage.



As one of North Carolina's principal conservation agencies, the Division of Parks and Recreation is responsible for more than 168,000 acres that make up our state parks system. The division manages these resources for the safe enjoyment of the public and protects and preserves them as a part of the heritage we will pass on to generations to come.

An important component of our stewardship of these lands is education. Through our interpretation and environmental education services, the Division of Parks and Recreation strives to offer enlightening programs that lead to an understanding and appreciation of our natural resources. The goal of our environmental education program is to generate an awareness in all individuals that cultivates responsible stewardship of the Earth.

For more information contact:

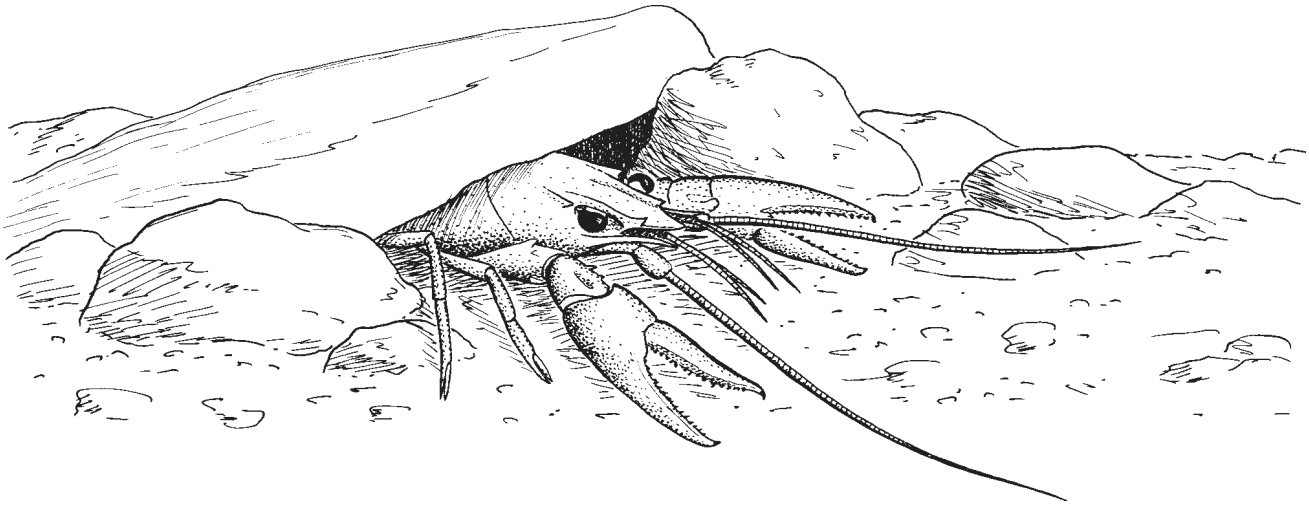
N.C. Division of Parks and Recreation
1615 Mail Service Center
Raleigh, NC 27699-1615
(919) 733-4181
www.ncsparks.net

Introduction to Lake Norman

Lake Norman is one of ten manmade lakes along the Catawba River, but it differs significantly in one aspect – size. In fact, Lake Norman is nearly as large as the other nine lakes combined! The larger lakes include Lake James, Lake Hickory, Lake Wateree and Lake Wylie. When Lake Norman is completely full, it covers 32,510 acres and has 520 miles of shoreline. It's no wonder the lake is nicknamed "the inland sea."

In 1959, 43 years after Duke Energy announced plans to build the lake, construction of this enormous resource began. Four years later, Cowan's Ford Dam, located near Huntersville, NC, was closed and the Catawba River began to back up and form Lake Norman. It took approximately three years to fill the huge basin created by the dam and another year to complete the entire Lake Norman project.

Today, Lake Norman provides electricity to the piedmont of North Carolina in two ways. First, it powers the hydroelectric generators at Cowan's Ford Dam, and second, it cools the steam that drives the turbines of Marshall Steam Station and McGuire Nuclear Station. The lake also serves as a water supply for several cities and protects downstream areas from flooding. A variety and abundance of wildlife also benefit from the lake, including osprey, ducks and many species of freshwater fish, such as largemouth and striped bass and catfish. Not only do wild animals call Lake Norman home; more than 60,000 people reside along its shores and enjoy boating, fishing, skiing and other water sports.



McCafferty: *Aquatic Entomology.*

Introduction to Lake Norman State Park

"Water, water, everywhere..." and there's plenty for everyone at Lake Norman State Park, which is located on the northeastern shore of Lake Norman. As if there isn't enough water in Lake Norman, the park has its own 33-acre lake, which is separated from Lake Norman by an earthen dam. But water is not all you'll find at the park; there are also about 1,500 acres of rich piedmont forest here, most of which was donated by Duke Energy. Together, the lake and forest provide homes for a multitude of wildlife. Waterfowl, including ducks, geese, great blue herons and kingfishers, are common sights around the water. Below the surface, you'll find a variety of freshwater fish, including largemouth and striped bass, crappie, catfish and bluegill. On the park grounds, there are white-tailed deer, wild turkeys, coyotes, red foxes, bobcats and groundhogs. The water and woods are also home to a variety of insects, amphibians and reptiles. Plant life is abundant; not only are there piedmont species, but there are several mountain plants as well, including mountain laurel and white pine. And don't forget to look up into the sky above the park, where you might see owls, woodpeckers, hawks and more than 150 species of migrating birds.

Of course, wildlife is not all you'll find at Lake Norman State Park. There are also various recreational facilities available. These include a community building, two picnic areas, a picnic shelter, more than six miles of hiking trails, a mountain bike trail, a swimming area, pedal boat and canoe rentals, and family and group campgrounds.

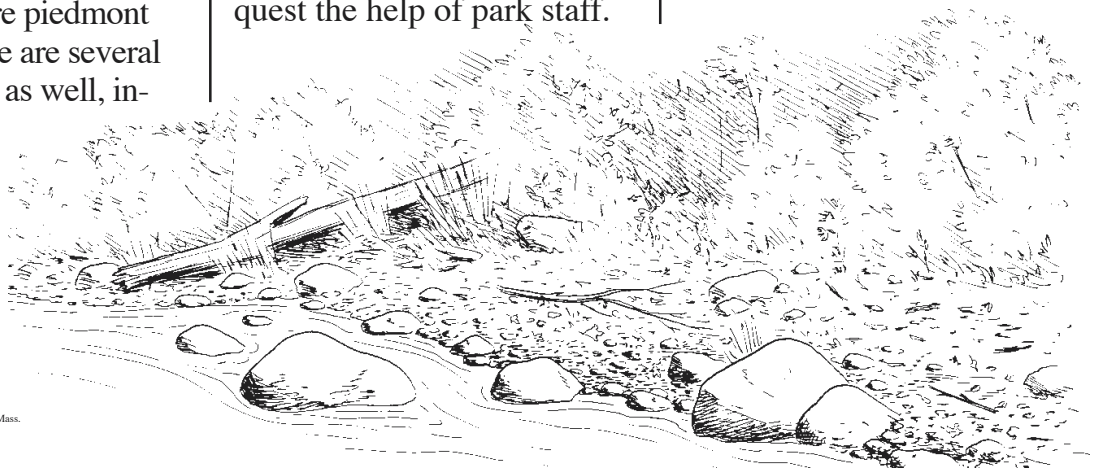
Guidelines for a Rewarding Experience at Lake Norman State Park

Groups are encouraged to visit the park during all seasons of the year for hikes, exploration, and environmental education programs and activities. Leaders may choose to conduct their own activities or request the help of park staff.

Scheduling a Trip

To make a reservation, contact the park at least two weeks in advance. Complete the scheduling worksheet on page 9.1 and provide the following information:

- Name of group (school).
- Name, address, work and home telephone numbers of the group contact person.
- Date, time of arrival and meeting place at the park.
- Departure time from the park.
- Number of participants and adult leaders. **A maximum of 30 participants is recommended. Please have one adult leader per 10 students. Adult leaders are responsible for maintaining control of the group.**
- Age range and/or special needs of participants.
- Desired activities; assistance needed by park staff.



McCafferty: *Aquatic Entomology.*

While at the Park

Please obey these rules:

1. To help you get the most out of the experience and increase the chance of observing wildlife, be as quiet as possible while in the park.

2. On hikes, walk behind the leader at all times. Stay on the trails. Running is not permitted.

3. All plants and animals within the park are protected. Breaking plants and harming animals are prohibited in all state parks. This allows future visitors the same opportunity to enjoy our natural resources.

4. Help keep the park clean and natural; do not litter. If you find litter left by others, please pick it up.

5. Swimming is permitted only in the designated swimming area under the supervision of park lifeguards.

6. In case of accidents or emergencies, contact park staff immediately.

Following the Trip

1. Complete the post-visit activities in this activity packet.

2. Build upon the field experience and encourage participants to seek answers to questions and problems encountered at the park.

3. Relate the experience to classroom activities and curriculum through reports, projects, demonstrations, displays and presentations.

4. Give tests or evaluations, if appropriate, to determine if students gained the desired information from the experience.

5. File a written evaluation of the experience with the park. An evaluation form is available on page 9.3.

Park Information

Address:
Lake Norman State Park
159 Inland Sea Lane
Troutman, NC 28166-9620
Telephone: (704) 528-6350
Fax: (704) 528-5623
E-mail: lano@i-america.net
Web: www.ncsparks.net/lano.html

Hours of Operation:

November - February	8 a.m. - 6 p.m.
March, October	8 a.m. - 7 p.m.
April, May, September	8 a.m. - 8 p.m.
June - August	8 a.m. - 9 p.m.

Park gates are locked at closing hours.
The park is closed Christmas Day.

Introduction to the Activity Packet for Lake Norman State Park

This Environmental Education Learning Experience (EELE), *Testing the Waters*, was developed to provide environmental education through a series of hands-on activities at Lake Norman State Park. This activity packet, designed to be implemented in grades 4 - 8, meets curriculum objectives of the standard course of study established by the N.C. Department of Public Instruction. It includes three types of activities: pre-visit, on-site and post-visit. The on-site activities will be conducted at the park, while pre- and post-visit activities are designed for the classroom. These activities should be performed in a series to build upon students' newly gained knowledge and experiences.

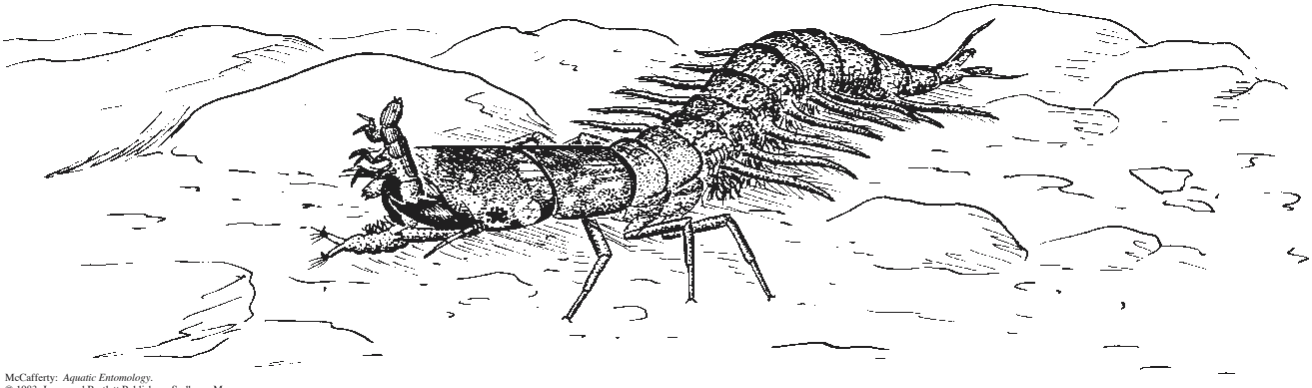
The EELE *Testing the Waters* will acquaint students with the following major concepts:

- **Water quality**
- **Watersheds**
- **Aquatic sampling**
- **Water pollution**
- **Preservation of natural areas**
- **Land use**

Vocabulary words used throughout this EELE will appear in **bold type** the first time they are used in each activity. These words and their definitions may be found in the vocabulary list at the back of the activity packet. A list of reference materials used in developing the activities follows the vocabulary list.

This document was designed to be reproduced, in part or entirety, for use in North Carolina classrooms. If you wish to photocopy or adapt it for other uses, please credit the N.C. Division of Parks and Recreation.

NOTE: The on-site activities may require hiking that could expose the students to hot, humid conditions and insects, venomous snakes and poisonous plants. Accessibility to some of these areas will be difficult for persons with physical disabilities.



McCafferty: *Aquatic Entomology.*

Activity Summary

The following outline provides a brief summary of each activity, the major concepts and learning skills introduced, and the objectives met by completion of the activity.

I. Pre-Visit Activities

#1 Key It Out (page 3.1.1)

Students will learn to use a dichotomous key through a series of fun activities. In Part I, students will use a simple key to identify unknown tree leaves. In Part II, the students will use a more complex key to identify macroinvertebrates found in Lake Norman.

Major Concepts:
- Dichotomous key
- Macroinvertebrate external anatomy
- Taxonomy

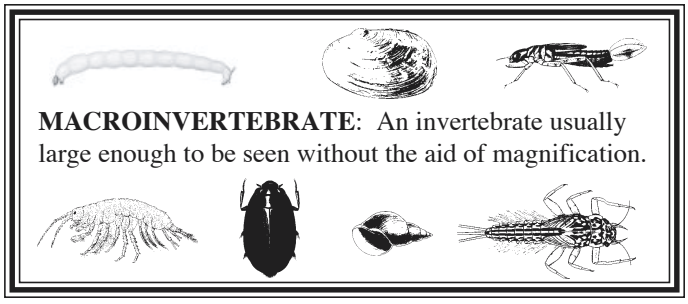
Learning Skills:
- Observing, classifying and communicating
- Reading informational materials (scientific keys)

Objectives:
- Use a dichotomous key to correctly identify pictures of ten unknown leaves and five unknown aquatic macroinvertebrates.
- Name at least two aquatic macroinvertebrates that are tolerant of pollution and two that are intolerant of pollution.
- Explain how people use aquatic macroinvertebrates to help determine the water quality of a river or other body of fresh water.

#2 Picture This (page 3.2.1)

By creating, presenting and displaying posters, students will become familiar with water-related words in the vocabulary section of this EELE.

Major Concepts:
- Water
- Water cycle
- Water quality
- Watershed



Learning Skills:
- Communicating
- Recognizing key words
- Creating visual representations of concepts

Objectives:
- Define the terms water, water cycle, watershed and water quality.
- Illustrate an aquatic vocabulary word and explain its meaning to other students.

#3 River Roots (page 3.3.1)

Students will understand the concept of watersheds and become familiar with the park lake watershed by outlining and identifying the features of the watershed on a topographic map and working in groups to answer questions on a worksheet.

Major Concepts:
- Watersheds
- Topographic maps

Learning Skills:
- Communicating, measuring, inferring and predicting
- Reading and interpreting topographic maps
- Measuring and estimating
- Working effectively in groups

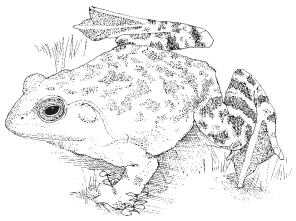
Objectives:
- Use a legend to identify common symbols on a topographic map such as the symbols for a creek, permanent structure, forested area and open area.
- Correctly locate specific geographic features on a topographic map such as rivers, mountains and watersheds.
- Use a map scale to estimate distances on a topographic map, and read contour lines to estimate elevations.
- Draw inferences from a topographic map regarding human activities and their possible effects on specific watersheds.

II. On-Site Activities

#1 Life at the Bottom (page 4.1.1)

Students will use different methods to collect and identify aquatic organisms and make inferences concerning the quality of the water based on their findings.

Major Concepts:
- Water quality
- Indicator species
- Aquatic sampling
- Macroinvertebrate external anatomy and adaptations
- Species identification
- Aquatic habitats



Learning Skills:
- Observing, classifying and communicating
- Interpreting data and making inferences
- Sampling and calculating aquatic index values

Objectives:
- Describe three characteristics of an aquatic macroinvertebrate.
- Key out and identify three macroinvertebrates in the field.
- Calculate the aquatic index value and aquatic index rating for a water body.
- List three or more ways humans can affect aquatic life.

#2 Water Lab (page 4.2.1)

Students will work in teams to conduct some simple physical and chemical tests (pH, turbidity and temperature) to determine the quality of a body of water.

Major Concepts:

- Water quality
- Turbidity
- pH
- Temperature

Learning Skills:

- Observing, communicating results, predicting, interpreting data
- Measuring
- Reading and interpreting scientific charts

Objectives:

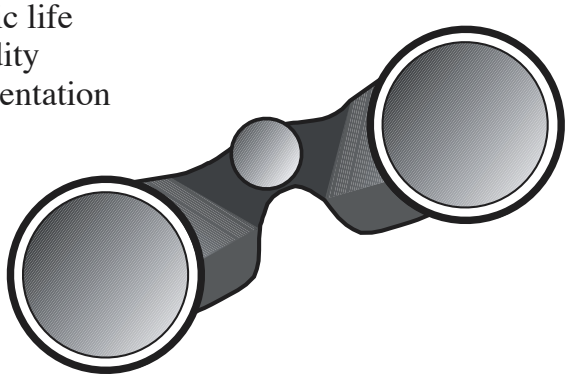
- Name and describe three characteristics of water that contribute to the overall quality of a water sample or body of water.
- Determine the pH, temperature and turbidity of lake water samples and make inferences regarding the overall water quality based on the test results.
- Using the test results and other information, write predictions for the kinds of aquatic life that might live in the lake.

#3 Lake Watchers (page 4.3.1)

Students will take a short nature walk along the lakeshore to get a glimpse at some of the major factors affecting local water quality. Students may also observe and identify aquatic wildlife.

Major Concepts:

- Water quality
- Recreation
- Runoff
- Urbanization
- Dams
- Water pollution
- Aquatic life
- Turbidity
- Sedimentation



Learning Skills:

- Observing, communicating, inferring
- Collecting, analyzing and evaluating information
- Map reading and taking responsible action

Objectives:

- Describe three positive effects and three negative effects of dams on people and wildlife.
- Describe two ways that people can minimize the negative environmental impacts of dams.
- Identify three examples of aquatic plants and animals found in the field.
- Use a topographic map to identify direction, elevation and landmarks in the field.
- Describe three characteristics of water that people can observe in order to make inferences about water quality.
- Explain how urbanization affects water quality.
- List two negative impacts of recreation on water quality.

III. Post-Visit Activities

#1 Park Lake (page 5.1.1)

Using a map of the park lake watershed and land use cutouts, student teams will create a land use plan for a portion of the Lake Norman area.

Major Concepts:

- Human impacts
- Land use issues
- Water quality
- Preservation of natural areas
- Stewardship

Learning Skills:

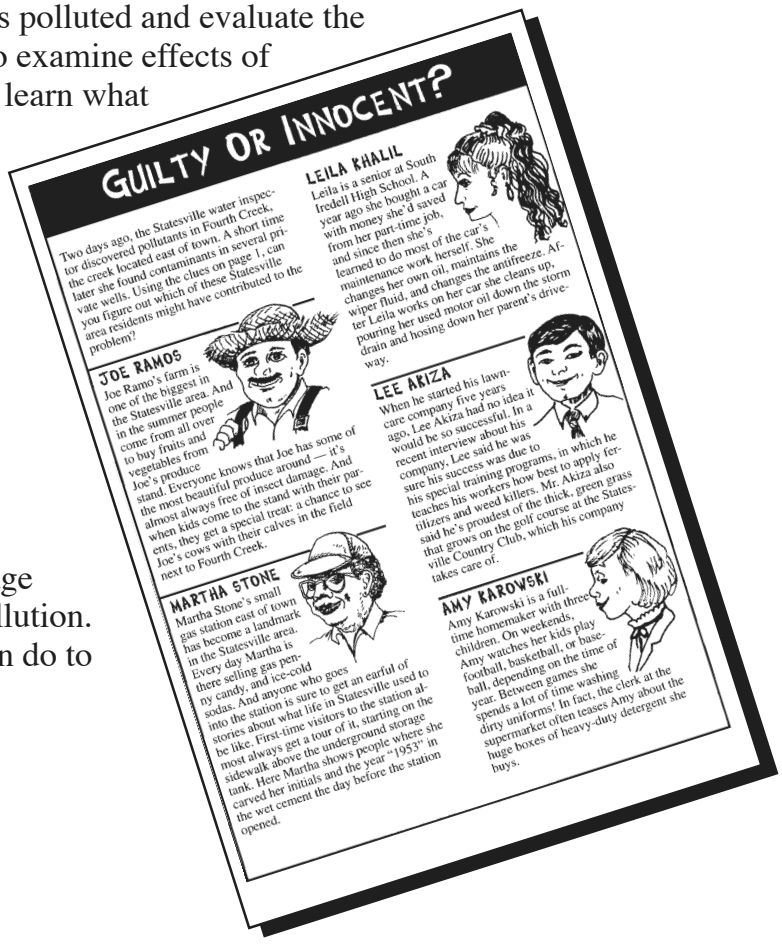
- Interpreting data, communicating, evaluating
- Organizing and analyzing information
- Problem solving and critical thinking skills

Objectives:

- Evaluate the potential effects of different land uses on water quality and aquatic life in the park lake.
- List and describe at least five things we can do as individuals or societies to protect water quality.
- Create a land use plan for a small watershed that minimizes damage to water quality.

#2 Guilty or Innocent? (page 5.2.1)

Students will discuss ways water becomes polluted and evaluate the actions of fictitious characters. They will also examine effects of their own actions on the quality of water and learn what they can do to minimize pollution.



Major Concepts:

- Water quality
- Environmental ethics
- Polluted runoff

Learning Skills:

- Communicating ideas verbally and through art
- Inferring and elaborating

Objectives:

- Describe at least five ways that average citizens might contribute to water pollution.
- Identify at least five things people can do to help prevent water pollution.

#3 Pollution Dilution (page 5.3.1)

Students will become familiar with the major types of aquatic pollution and predict the potential effects of a variety of aquatic pollutants on wildlife and people.

Major Concepts:

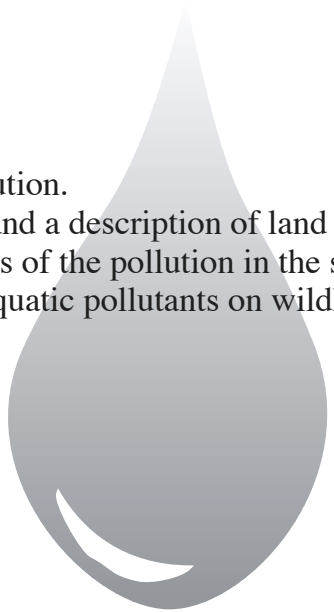
- Water pollution
- Watershed
- Point pollution
- Nonpoint pollution

Learning Skills:

- Interpreting data, communicating
- Graphing
- Organizing and analyzing information

Objectives:

- List at least four major types of aquatic pollution.
- Given a list of pollutants in a water sample and a description of land use in a watershed, make inferences on the probable causes of the pollution in the sample.
- Predict the potential effects of a variety of aquatic pollutants on wildlife and people.

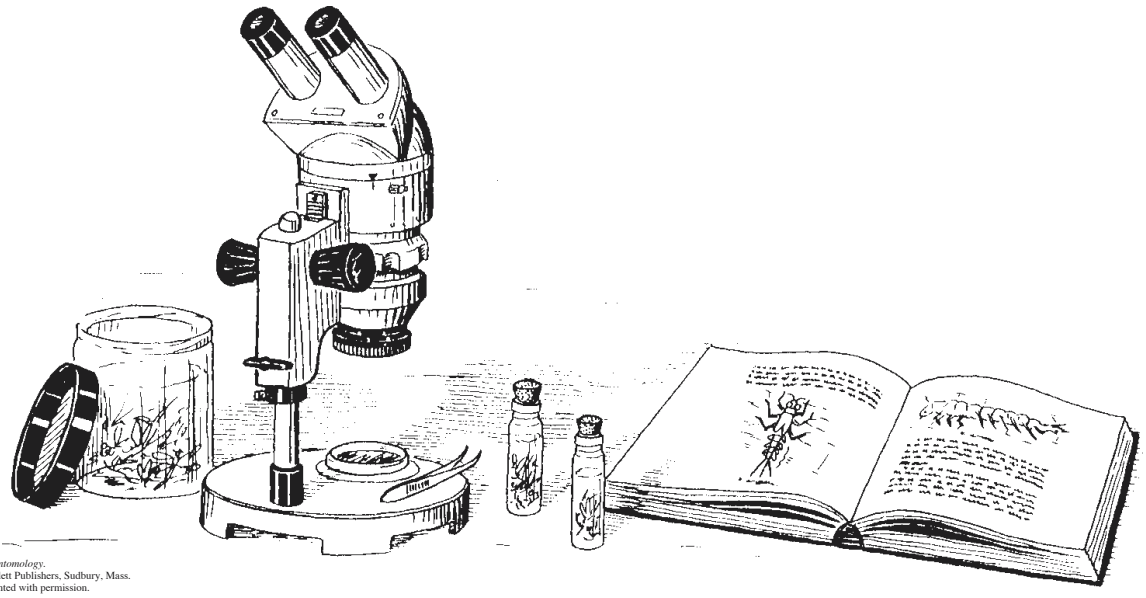


Correlation Chart

Note to classroom teachers: The following Correlation Chart shows how each activity in this Environmental Education Learning Experience (EELE) correlates with the N.C. Department of Public Instruction (DPI) objectives in science, mathematics, social studies and English language arts. The activities are listed in the order in which they appear in this EELE. The recommended grade levels are listed along the side of the chart. Notice that only the objective numbers are listed. Use your DPI Teacher Handbook for each subject area to get a complete description of the objectives in that subject area.

Pre-Visit Activity #1: Key It Out, p. 3.1.1

Grade	Science	English Lang. Arts	Soc. Studies	Mathematics
4	1.01, 1.02 Nature of Science Personal & Social Persp.	Goal 1 and 2.01, 2.02, 2.05, 2.06, 3.06, 4.02, 4.03		2.7
5	1.02, 1.05, 1.06 Nature of Science Personal & Social Persp.	Goal 1 and 2.01, 2.02, 2.05, 2.07, 2.09, 3.01, 3.06, 4.03		
6	2.02, 2.03, 2.04 Nature of Science Personal & Social Persp.	1.03, 1.04, 2.01, 2.02, 5.01, 6.01		
7		1.03, 1.04, 2.01, 2.02, 5.01, 6.01		
8	1.04 Nature of Science Personal & Social Persp.	1.03, 1.04, 2.01, 2.02, 5.01, 6.01		



McCafferty: *Aquatic Entomology*.

Correlation Chart

Pre-Visit Activity #2: Picture This, p. 3.2.1

Grade	Science	English Lang. Arts	Soc. Studies	Mathematics
4	1.03 Nature of Science Personal & Social Persp.	1.03, 1.05, 2.01, 2.07, 3.05, 3.06, 4.02, 4.03, 4.09, 5.01, 5.06		
5	1.06, 4.01 Nature of Science Personal & Social Persp.	Goal 1 and 2.01, 2.07, 3.01, 3.05, 3.06, 4.09, 5.01, 5.05, 5.07		
6	2.03 Nature of Science Personal & Social Persp.	2.01, 2.02, 5.01, 5.02		
7		2.01, 2.02, 5.01, 6.01		
8	1.01, 2.02 Nature of Science Science as Inquiry	2.01, 2.02, 5.01, 6.01		

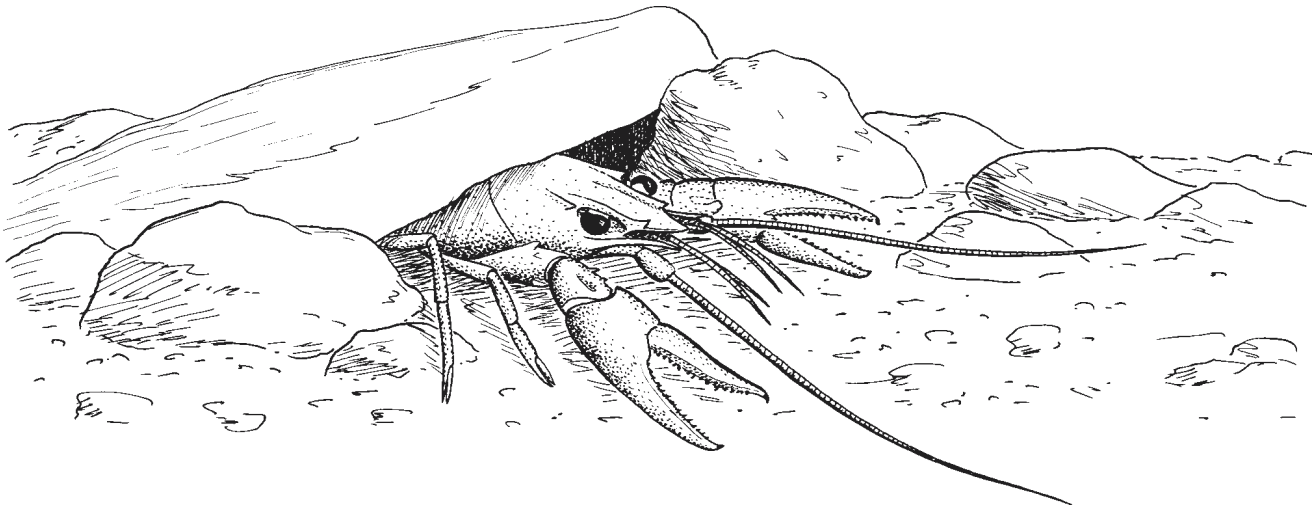
Pre-Visit Activity #3: River Roots, p. 3.3.1

Grade	Science	English Lang. Arts	Soc. Studies	Mathematics
4	1.03 Nature of Science Personal & Social Persp.	Goal 1 and 2.01, 2.05, 2.06, 2.07, 4.02	1.01, 1.04, 6.04 Skills: 1.01, 1.02, 1.03, 1.04, 1.08, 3.01, 4.05, 4.06	1.2, 2.1, 2.7, 2.10
5	1.06 Nature of Science Personal & Social Persp.	Goal 1 and 2.01, 2.05, 2.08, 2.09, 4.02	1.01, 1.06 Skills: 1.01, 1.02, 1.03, 1.04, 1.08, 3.01, 4.05, 4.06	2.1, 2.2, 2.9, 2.10
6	1.03, 2.03 Nature of Science Personal & Social Persp.	1.03, 2.01, 5.01		2.8, 2.9, 2.12, 2.13
7		1.03, 2.01, 5.01		
8	1.04, 1.05, 2.02 Nature of Science Personal & Social Persp.	1.03, 2.01, 5.01		2.1, 2.2

Correlation Chart

On-Site Activity #1: Life at the Bottom, p. 4.1.1

Grade	Science	English Lang. Arts	Soc. Studies	Mathematics
4	1.01, 1.02, 1.03 Nature of Science Science as Inquiry	Goal 1 and 2.01, 2.02, 2.06, 2.07, 4.02, 4.09		1.17, 4.2, 4.3, 4.4
5	1.01, 1.02, 1.03, 1.05, 1.06 Nature of Science Science as Inquiry	Goal 1 and 2.01, 2.02, 2.07, 2.09, 4.02, 4.03, 4.09		4.2, 4.3, 4.8
6	2.02, 2.03, 2.04 Nature of Science Science as Inquiry	1.03, 2.01, 5.01, 6.01		4.1, 4.2, 4.9
7		1.03, 2.01, 2.02, 5.01, 6.01		4.3, 4.4
8	1.02, 1.04, 2.03 Nature of Science Science as Inquiry	1.03, 2.01, 2.02, 5.01, 6.01		4.4



Correlation Chart

On-Site Activity #2: Water Lab, p. 4.2.1

Grade	Science	English Lang. Arts	Soc. Studies	Mathematics
4	1.03 Nature of Science Science as Inquiry	Goal 1 and 2.01, 2.02, 2.06, 2.07, 4.02, 4.09		2.7, 4.2, 4.3, 4.4, 4.5
5	1.03, 1.04 Nature of Science Science as Inquiry	Goal 1 and 2.01, 2.02, 2.07, 2.09, 4.02, 4.03, 4.09		2.9. 4.1, 4.2, 4.3, 4.5, 4.6
6	2.03 Nature of Science Science as Inquiry	1.03, 2.01, 5.01, 6.01		2.11, 2.12, 4.1, 4.2
7	1.04, 4.05 Nature of Science Science as Inquiry	1.03, 2.01, 2.02, 5.01, 6.01		4.4, 4.5
8	1.02, 1.04, 1.05, 2.03 Nature of Science Science as Inquiry	1.03, 2.01, 2.02, 5.01, 6.01		2.12, 4.3, 4.4

On-Site Activity #3: Lake Watchers, p. 4.3.1

Grade	Science	English Lang. Arts	Soc. Studies	Mathematics
4	1.03 Nature of Science Science as Inquiry Personal & Social Persp.	4.02, 4.03, 4.05, 4.07	1.01, 1.03, 1.04, 6.04, 7.02 Skills: 3.01, 3.02, 4.01, 4.05, 4.06	
5	1.04, 1.06, 3.01 Nature of Science Science as Inquiry Personal & Social Persp.	4.02, 4.03, 4.09	1.01, 1.06, 5.01, 6.02 Skills: 3.01, 3.02, 4.01, 4.05, 4.06	
6	1.03, 2.03 Nature of Science Science as Inquiry Personal & Social Persp.	3.01, 3.02, 3.03, 5.01, 6.01		
7		3.01, 3.02, 3.03, 5.01, 6.01		
8	1.04, 1.05, 2.02, 2.03, 2.05 Nature of Science Science as Inquiry Personal & Social Persp.	3.01, 3.02, 3.03, 5.01, 6.01		

Correlation Chart

Post-Visit Activity #1: Park Lake, p. 5.1.1

Grade	Science	English Lang. Arts	Soc. Studies	Mathematics
4	1.03, 4.01 Personal & Social Persp. Science & Technology	1.04, 2.02, 2.05, 2.07, 2.09, 3.01, 3.06, 4.02, 4.03, 5.01	1.01, 1.03, 1.04, 1.05, 4.03, 6.01, 6.02, 6.04, 7.05 Skills: 1.04, 1.05, 2.01, 2.04, 2.05, 2.06, 3.01, 4.01, 4.02, 4.05, 4.06, 4.07	
5	1.04, 1.06, 3.01 Personal & Social Persp. Science & Technology	1.03, 2.02, 2.05, 2.07, 2.09, 3.01, 3.06, 4.02, 4.03, 5.01	1.01, 1.02, 1.06, 5.01, 6.02 Skills: 1.04, 1.05, 2.01, 2.04, 2.05, 2.06, 3.01, 4.01, 4.02, 4.05, 4.06, 4.07	
6	1.03, 2.03 Personal & Social Persp. Science & Technology	1.03, 2.01, 2.02, 3.02, 4.02, 4.03, 5.01, 6.01		
7	1.04 Personal & Social Persp. Science & Technology	1.03, 2.01, 2.02, 3.02, 4.02, 4.03, 5.01, 6.01		
8	1.04, 1.05, 2.01, 2.02, 2.03, 2.05 Personal & Social Persp. Science & Technology	1.03, 2.01, 2.02, 3.02, 4.02, 4.03, 5.01, 6.01	9.01, 9.03 Skills: 1.04, 1.05, 2.01, 2.04, 2.05, 2.06, 3.01, 4.01, 4.02, 4.05, 4.06, 4.07	

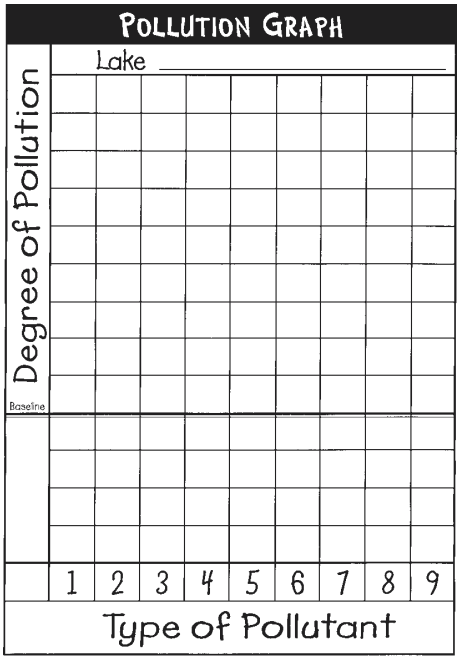
Post-Visit Activity #2: Guilty or Innocent?, p. 5.2.1

Grade	Science	English Lang. Arts	Soc. Studies	Mathematics
4	1.03 Personal & Social Persp.	Goal 1, 2.01, 2.02, 2.05, 2.06, 2.07, 3.01, 4.02, 5.01, 5.02, 5.03	1.04, 4.03, 6.04, 7.04 Skills: 1.01, 1.02, 1.03, 1.04, 4.01, 4.05, 4.06	
5	1.06, 2.02 Personal & Social Persp.	Goal 1, 2.01, 2.02, 2.05, 2.07, 3.01, 4.02, 5.01, 5.02, 5.03	1.06, 6.02 Skills: 1.01, 1.02, 1.03, 1.04, 4.01, 4.05, 4.06	
6	1.03, 2.03 Personal & Social Persp.	1.04, 2.01, 4.02, 4.03, 5.01, 6.01		
7		1.04, 2.01, 4.02, 4.03, 5.01, 6.01		
8	1.04, 1.05, 2.05 Personal & Social Persp.	1.04, 2.01, 4.02, 4.03, 5.01, 6.01	9.01, 9.03 Skills: 1.01, 1.02, 1.03, 1.04, 4.01, 4.05, 4.06	

Correlation Chart

Post-Visit Activity #3: Pollution Dilution, p. 5.3.1

Grade	Science	English Lang. Arts	Soc. Studies	Mathematics
4	1.03 Science as Inquiry Personal & Social Persp.	Goal 1, 2.01, 2.02, 2.05, 2.09, 3.01, 4.02, 4.03, 4.05, 5.01, 5.02, 5.03	1.04, 4.03, 6.01, 6.04, 7.04 Skills: 1.01, 1.02, 1.03, 1.04, 1.06, 2.06, 3.02, 4.01, 4.06	4.2, 4.3, 4.4
5	1.04, 1.06 Science as Inquiry Personal & Social Persp.	Goal 1, 2.01, 2.02, 2.05, 2.09, 3.01, 4.02, 4.03, 4.05, 5.01, 5.02, 5.03	1.06, 5.01, 6.02 Skills: 1.01, 1.02, 1.03, 1.04, 1.06, 2.06, 3.02, 4.01, 4.06	4.2
6	1.03, 2.03 Science as Inquiry Personal & Social Persp.	1.03, 2.01, 3.03, 4.02, 4.03, 5.01, 6.01		4.1, 4.5, 4.7, 4.8
7		1.03, 2.01, 3.03, 4.02, 4.03, 5.01, 6.01		4.2, 4.3, 4.4
8	1.04, 1.05, 2.01, 2.02, 2.03, 2.05 Science as Inquiry Personal & Social Persp.	1.03, 2.01, 3.03, 4.02, 4.03, 5.01, 6.01	9.01, 9.03 Skills: 1.01, 1.02, 1.03, 1.04, 1.06, 2.06, 3.02, 4.01, 4.06	4.4



Pre-Visit Activity #1 — Key It Out

Major Concepts:
- Dichotomous key
- Macroinvertebrate external anatomy
- Taxonomy

Learning Skills:
- Observing, classifying, communicating
- Reading informational materials (scientific keys)

Subject Areas:
- Science
- English Language Arts
- * See the Activity Summary for a correlation with DPI objectives in these subject areas.

Special Considerations:
None

Location: Classroom

Group Size:
30 students, class size

Estimated Time:
Part I: 20 - 30 minutes
Part II: 30 - 50 minutes

Appropriate Season: Any

Materials:
Provided by educator:
Per student: Student's Information, Key to 10 Common Leaves, Ten Common Leaves Worksheet, pencil
Per group: Key to Aquatic Macroinvertebrates – Catawba River Watershed and Aquatic Life Illustrations Worksheet

Objectives:

- Use a dichotomous key to correctly identify pictures of ten unknown tree leaves and five unknown aquatic macroinvertebrates.
- Name at least two aquatic macroinvertebrates that are tolerant of pollution and two that are intolerant of pollution.
- Explain how people use aquatic macroinvertebrates to help determine the water quality of a river or other body of fresh water.

Educator's Information:

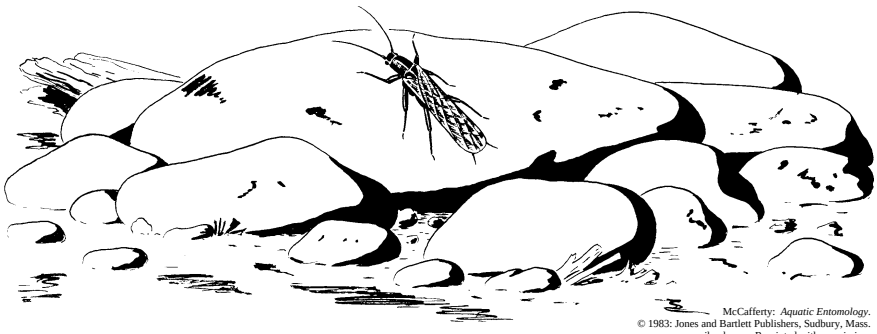
The purpose of this two-part activity is to introduce students to a simple **dichotomous** key. In Part I, students will learn why **keys** are useful to scientists and will be introduced to the use of a simple key. In Part II, the students will work in small groups and will key out several **macroinvertebrates** using a key similar to the one they will use at the park for the on-site activity "Life at the Bottom."

Instructions for Part I:

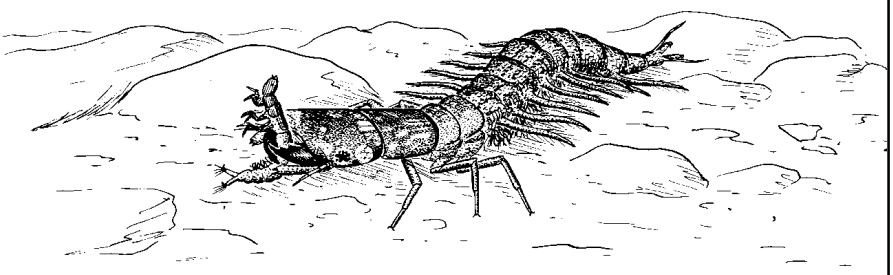
Have the students read the Student's Information. Discuss **taxonomy** and how **organisms** are classified into naturally related groups. Define a key and discuss why keys are useful. Explain how a key works. Give each student a copy of the Key to 10 Common Leaves and Ten Common Leaves Worksheet. Ask each student to work through this key to identify each of the 10 tree leaves. As a class, go over the answers and discuss any difficulties encountered.

Instructions for Part II:

Divide the students into groups of four or five. Give each group a copy of the Aquatic Life Illustrations Worksheet and the Word Key to Aquatic Macroinvertebrates of the Catawba River Watershed. *Note: For young students, you may prefer to use the Picture Key to Aquatic Macroinvertebrates, also found in this activity.* As a class, work through the key to identify the first animal,



McCafferty: *Aquatic Entomology*.



then have the students work within their groups to identify the rest of the macroinvertebrates. When the groups are done, have each group share how they identified one of their macroinvertebrates. Discuss the difficulties encountered and reinforce the importance of keys.

The keys also list whether an animal is tolerant, moderately tolerant or intolerant of water **pollution**. Discuss: If your lake, stream or other water body had the particular combination of animals found on the Aquatic Life Illustrations Worksheet, what can you conclude about the **water quality**? Answer: The water quality must be fairly good to have at least one intolerant **species** present, as well as a variety of moderately tolerant species. If there were only tolerant species present, then one might conclude the water quality was poor. The diversity, or lack of diversity, of macroinvertebrates in a water body helps us determine water quality. Generally, the greater the variety of species, the better the water quality is.

Assessment:

Use the test included in this activity or create one of your own. On the back of their test papers, ask students to explain how people use macroinvertebrates to help them determine the water quality of a water body.

Suggested Extensions:

1. Ask students research the **metamorphosis** of several **aquatic** insects. Many **insects** undergo an *incomplete* metamorphosis: egg to **nymph** to adult. Examples are dragonflies, damselflies and mayflies. Other aquatic insects undergo a *complete* metamorphosis: egg to **larva** to **pupa** to adult. (A butterfly is a terrestrial insect that has complete metamorphosis.) Examples of aquatic insects are mosquitoes, craneflies and caddisflies.

The educator could assign one of the aquatic insects in the picture key to each student or team of students. The students should present information on the life cycle of their insect and include illustrations of each stage in the life cycle.

2. Students might also do research to learn more about the **adaptations** of each macroinvertebrate in the picture key. For example, how does each animal breathe? Mosquito larvae have a snorkel-like tube, while mayflies and damselflies have leafy gills. How do the insects swim or move? What type of camouflage do they employ? What is their preferred **habitat**? Do they show any colonial behaviors?

3. Groups of students could work together to illustrate aquatic **food webs** using the macroinvertebrates in the picture key, and other animals. Remember that most food webs begin with energy from the sun. Add aquatic plants and **detritus**, especially fallen leaves, to your food webs.

Where do the various animals on the picture key fit in the food web? Which ones are *primary* **consumers**? (Example: mosquito larvae) Which are *secondary* consumers? (Example: dragonflies) Which are **decomposers**? (Example: caddisfly larvae) Add higher level consumers such as fish, turtles, raccoons and people to your food web.

Student's Information – Part I

Taxonomy is the branch of **biology** that classifies **organisms** by established groups. The word *taxonomy* comes from Greek words meaning arrangement and law. Through taxonomy, organisms are placed into related groups based on their similarities.

All organisms are grouped into large groups known as kingdoms. There are five major kingdoms:

1. Animalia (mammals, **insects**, birds, reptiles, etc.)
2. Plantae (plants)
3. Fungi (mushrooms, molds, yeasts, etc.)
4. Protista (some **algae** and protozoans)
5. Monera (bacteria and blue-green algae)

These kingdoms are further divided into smaller, more closely related groups. For example, let's trace the taxonomic **classification** of a dragonfly called the ten-spot skimmer. Dragonflies belong to the Kingdom Animalia. From here, they are placed into a smaller group called a phylum. Dragonflies belong to Phylum Arthropoda, which contains all insects and insect relatives, such as spiders, crabs and scorpions. The phylum groups are divided into smaller groups called classes. Dragonflies belong to the Class Insecta. A class is further divided into groups called orders. In North America, there are 27 orders of insects. Dragonflies are in the Order Odonata. The next two divisions are family and **genus**. The final division is **species**. Worldwide there are about 4,500 species of dragonflies, while in North Carolina there are only 186 species. If you have a dragonfly and want to know what species you have, you could use a **key**.

Example: Classification of the Ten-Spot Skimmer

Kingdom	Animalia
Phylum	Arthropoda
Class	Insecta
Order	Odonata
Family	Libellulidae
Genus	Libellula
Species	pulchella

Keys:

A key is a list of characteristics that describe an organism. Keys are used by scientists and students to identify unknown organisms. Keys often use a combination of pictures and written descriptions to aid in identification. Once you know the name of an organism you can look up more information about it. It all starts with a name!

Dichotomous Keys:

Most keys are **dichotomous**, meaning they divide the characteristics that describe an organism into two choices. At each level of the key, you pick the choice that best describes the organism you are trying to identify.

How a Key Works:

A dichotomous key has a list of either/or statements. For each pair of statements, choose the one that best describes the organism you're trying to identify. For example, if you were handed a leaf from a pine tree to identify, you would start at the top of the key with these two choices:

1. Leaves long and needle-like.
2. Leaves not long and needle-like.

Of course, a pine leaf (or needle) is long and needle-like, so you would choose the first option and continue to the next choice under that side of the dichotomous key.

Student's Information – Part II

Who Cares about Macroinvertebrates?

You may be wondering why anyone would go through all the trouble to key out the name of a particular water "bug" or **macroinvertebrate**. It turns out that these small organisms are very helpful to humans. For example, they can help us find out if our **water quality** is good, or if there are problems that we can't see or smell with the water. Whenever we pollute the water, the macroinvertebrates are affected, some more than others.

Notice that each macroinvertebrate's name on the key is followed by a letter "T" (tolerant of **pollution**), "I" (intolerant of pollution) or "M" (moderately tolerant of pollution). If you find only macroinvertebrates that are tolerant of pollution in a river and no moderately tolerant or intolerant species, this tells you the river has poor water quality. You might want to look more carefully to discover the sources of pollution that are damaging the water quality. Some of these pollutants could be harmful to people who might swim, fish or play in the river. If the river is a source of drinking water, poor water quality is of special concern.

Food Webs

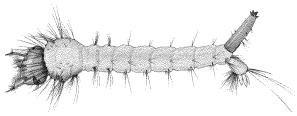
Macroinvertebrates are important for other reasons, too. All macroinvertebrates play an important role in the **food web** of a river or stream. Some of the macroinvertebrates are predators that eat other animals. For example, the dragonfly **nymph** and the giant water bug are predators. Other macroinvertebrates, like freshwater **mussels**, scuds and caddisfly **larvae**, eat **detritus** (decaying materials) in the water. Some, like leeches, are parasites on fish, turtles and mammals.

Many fish depend on **aquatic** macroinvertebrates for food. Without them, most of the fish would starve and the food web would begin to collapse. Mussels, snails and crayfish are eaten by a wide variety of animals, including some terrestrial (land-based) species such as the raccoon. In some parts of the world, fish and other aquatic animals are a food item for people.

So the next time you see an "ugly bug" in the water, don't turn away in disgust. Learn its name by keying it out. This little animal can tell you what's happening to your favorite swimming hole or to the water supply for your city. And, it's part of a food web that suports your favorite game fish and many other animals.

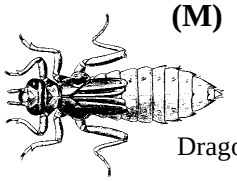
Tolerant Species (T)

Blackfly Larva

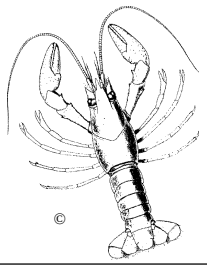


Mosquito Larva

Moderately Tolerant Species (M)

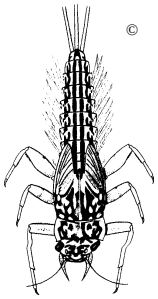


Dragonfly Nymph

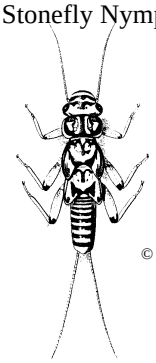


Crayfish

Intolerant Species (I)



Mayfly Nymph

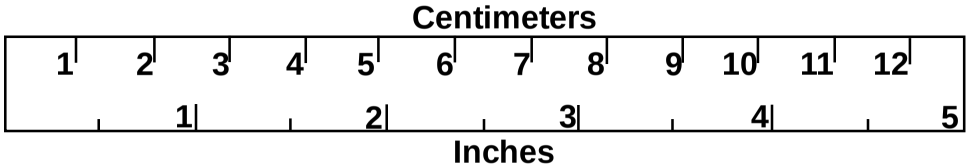


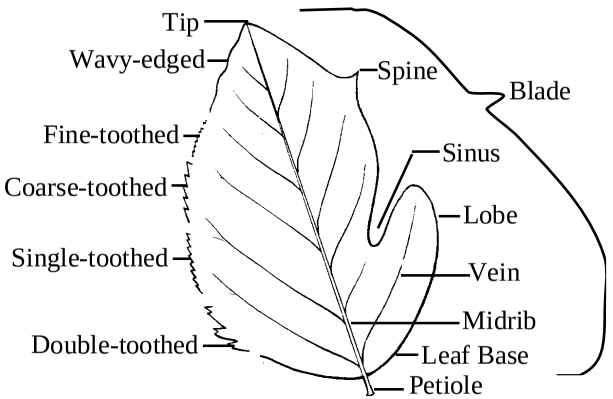
Stonefly Nymph

Key to 10 Common Leaves

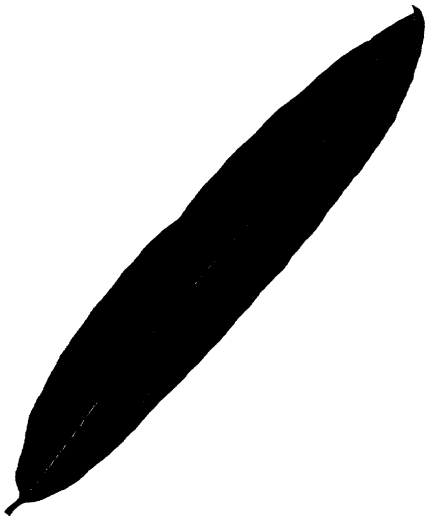
(Tree Leaves)

- Leaf long & needle-like
  - Leaves in group of 2, less than 10 cm long — *Shortleaf pine*
  - Leaves in group of 3, more than 10 cm long — *Loblolly pine*
- Leaf not needle-like
  - Leaf with lobes
    - Edge of leaf without teeth
      - Petiole of leaf 1 cm or longer
        - Leaf petiole less than 2 cm — *Sassafras*
        - Leaf petiole longer than 2 cm — *Tulip poplar*
      - Petiole of leaf less than 1 cm — *White oak*
    - Edge of leaf with teeth
      - Leaf with 5 lobes, petiole 3.5 cm or longer — *Sweet gum*
      - Leaf with 3 lobes, petiole shorter than 3.5 cm — *Red maple*
  - Leaf without lobes
    - Leaf edge with teeth
      - Each tooth with spine — *American holly*
      - Teeth without spines — *River birch*
    - Leaf without teeth — *Willow oak*

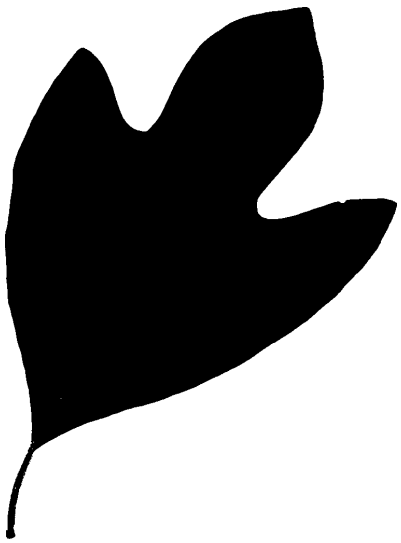




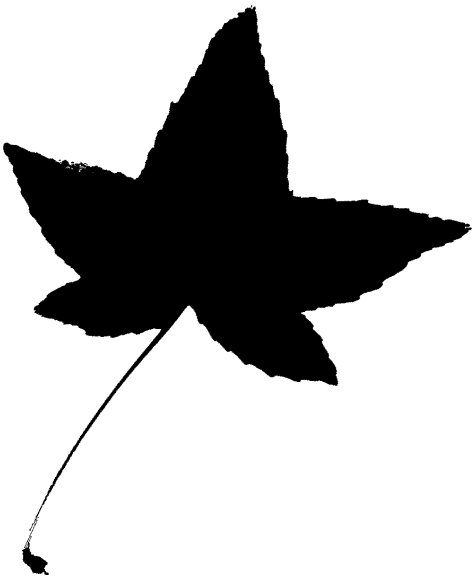
Ten Common Leaves Worksheet



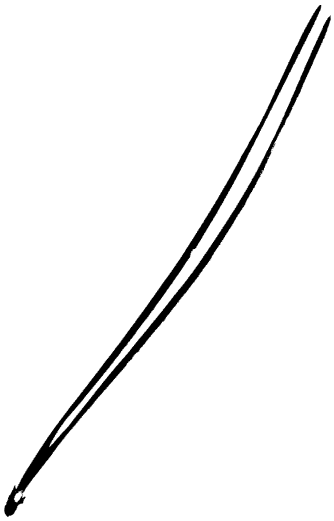
1. _____



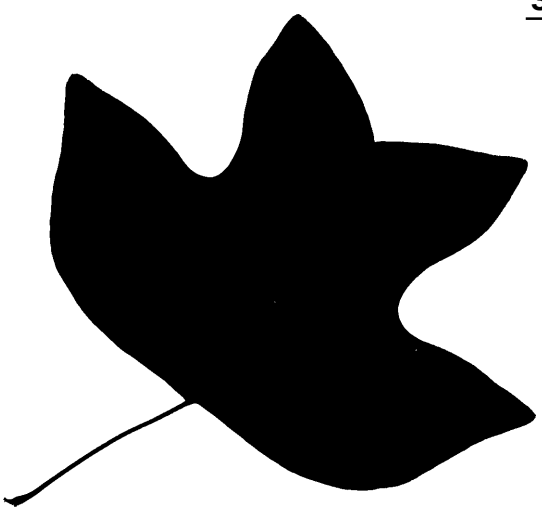
2. _____



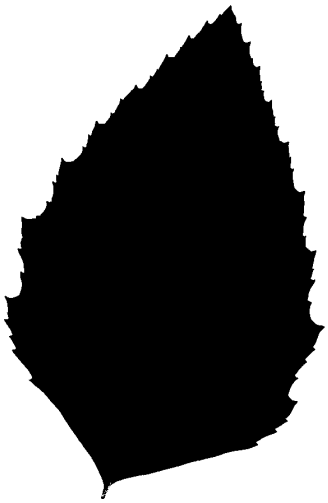
3. _____



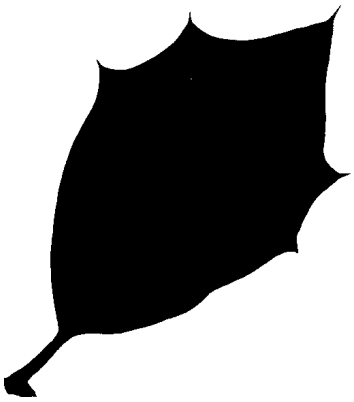
4. _____



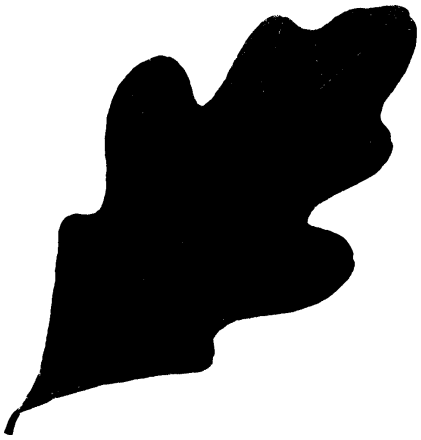
5. _____



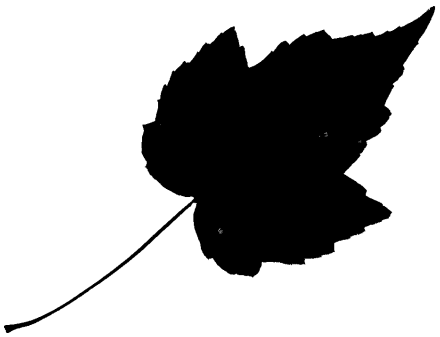
6. _____



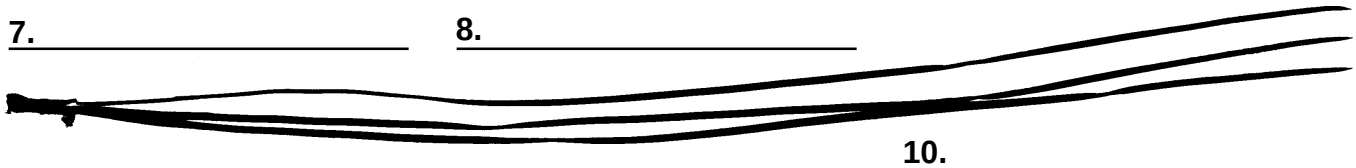
7. _____



8. _____

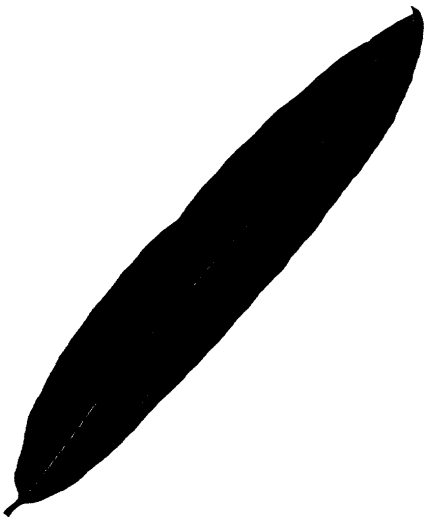


9. _____



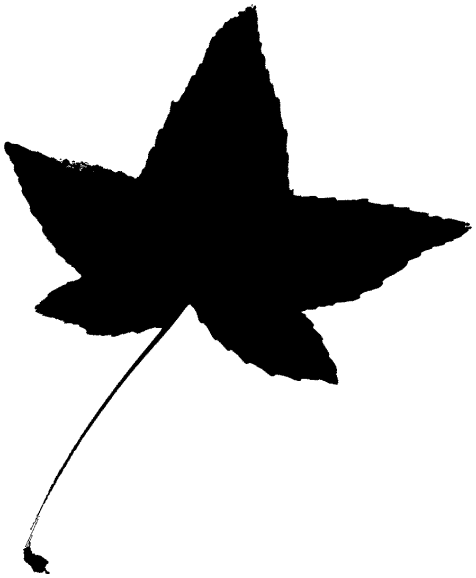
10. _____

Ten Common Leaves Worksheet – Answers

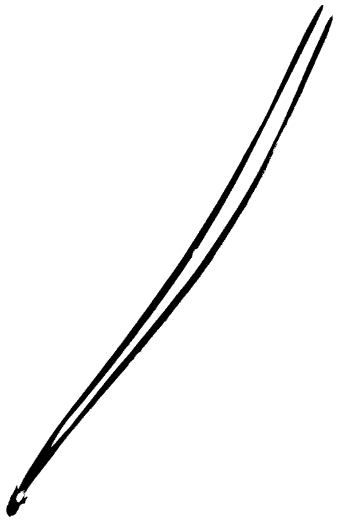


1. *Willow oak*

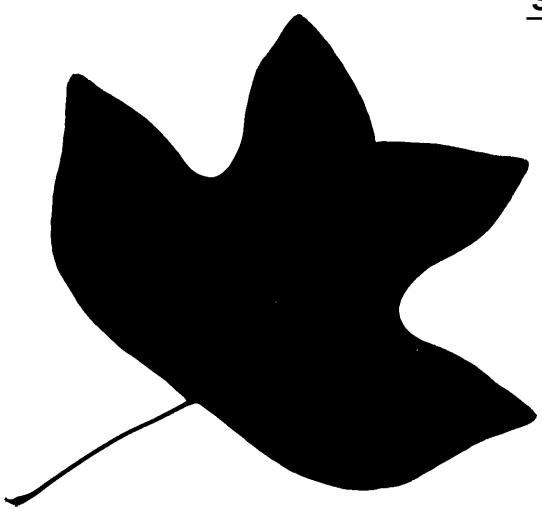
2. *Sassafras*



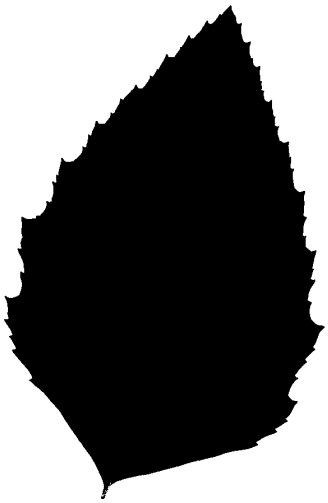
3. *Sweet gum*



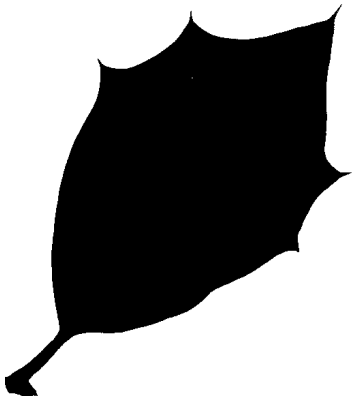
4. *Shortleaf pine*



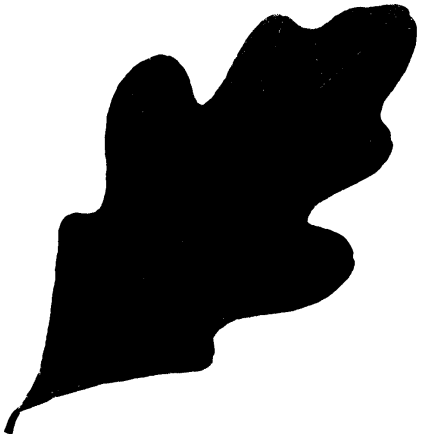
5. *Tulip poplar*



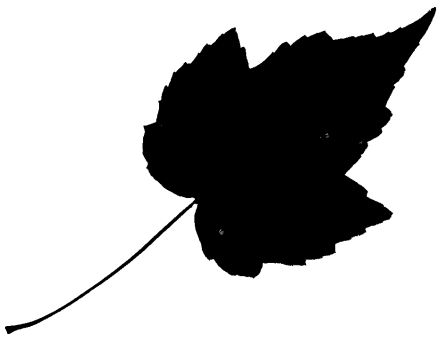
6. *River birch*



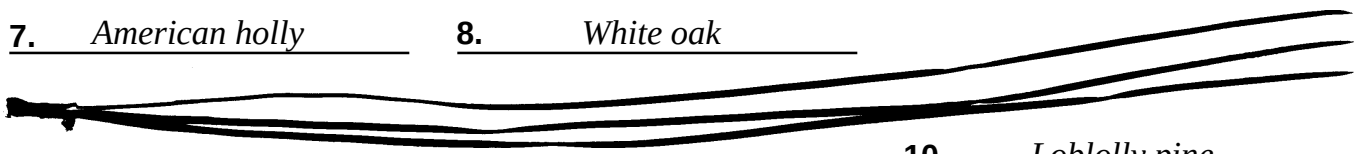
7. *American holly*



8. *White oak*



9. *Red maple*



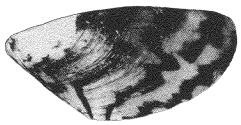
10. *Loblolly pine*

Picture Key to Aquatic Macroinvertebrates

Macroinvertebrates

with shells, clam-like

shell attached to submerged objects



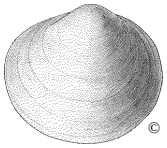
*Zebra mussel (T)

shell unattached

shell oblong

Native freshwater mussel (I)

shell triangular



*Asian clam (T)

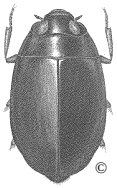
obvious legs

three pairs of legs

adult bugs or beetles with two pairs of wings

chewing mouth parts, front wings thick (beetles)

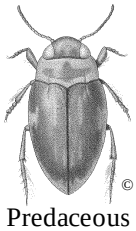
hind legs short (swims on surface)



Whirligig beetle (M)

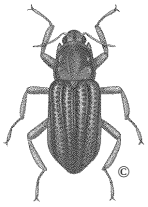
hind legs long

hind legs paddle-like (swims rapidly)



Predaceous diving beetle (M)

hind legs not paddle-like (crawls on submerged objects)

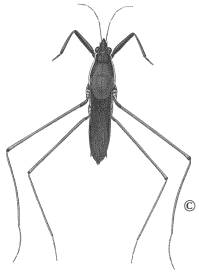


Riffle beetle (I)

sucking mouth parts (true bugs)

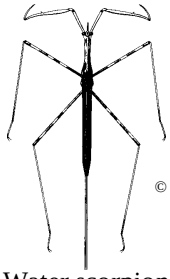
thin body, long spider-like legs

skates on water surface



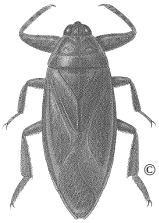
Water strider (M)

walks on bottom near plants, long tube on abdomen



Water scorpion (M)

thick body, up to 3" long



Giant water bug (M)

larvae or nymphs with no wings, but some have undeveloped wing pads

abdomen soft and worm-like

dark brown to black body, prominent pinching jaws

Hellgrammite, Dobsonfly larva (I)

white to greenish body, with or without portable case

Caddisfly larva (I)

Caddisfly larva with case (I)

** Non-native nuisance species. The zebra mussel is not yet known in North Carolina. It is moving into the southern states. Report its occurrence to park, wildlife or Duke Energy authorities.*

Catawba River Watershed

LEGEND	
Pollution Tolerance	**Index Value**
(I) – Intolerant	**Group I**
(M) – Moderate	**Group II**
(T) – Tolerant	**Group III**

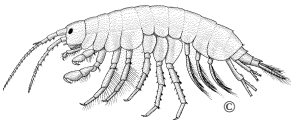
without shells

no obvious legs

more than three pairs of legs (crustaceans)

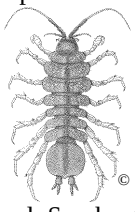
small claws on front legs, may be hard to see

body flattened side to side



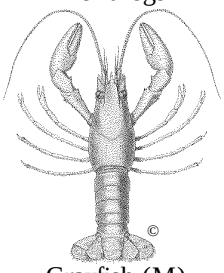
Amphipod, Scud (M)

body flattened top to bottom



Isopod, Sowbug (M)

large claws on front legs

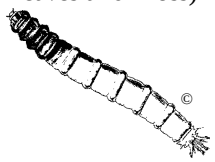


Crayfish (M)

worm-like

small appendages and / or hairs

no obvious head (lives on submerged leaves and moss)



Cranefly larva (M)

obvious head

fat, rounded abdomen (lives in groups, attaches to rocks and sticks)

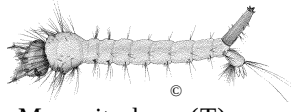
Black fly larva (T)

long, slender abdomen

bright red body (lives on submerged objects)

Chronomid midge (T)

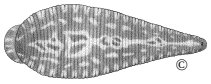
small hairs on body (lives in stagnant water)



Mosquito larva (T)

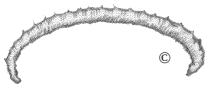
no appendages

flattened, gray to black color



Leech (T)

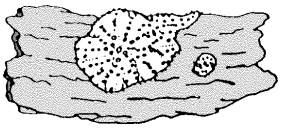
cylindrical, red color



Aquatic worm (T)

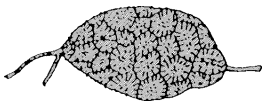
sponge- or jelly-like, grows on submerged objects

usually a flattened pad



Freshwater sponge (M)

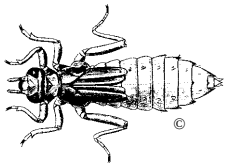
ball-like



Bryozoa (M)

entire body (exoskeleton) hardened and flattened

no obvious tail

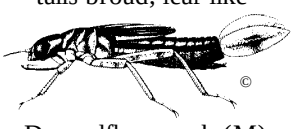


Dragonfly nymph (M)

obvious tail

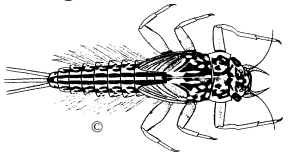
three tails

tails broad, leaf-like



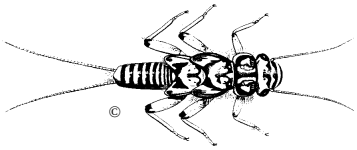
Damselfly nymph (M)

tails slender, gills on abdomen



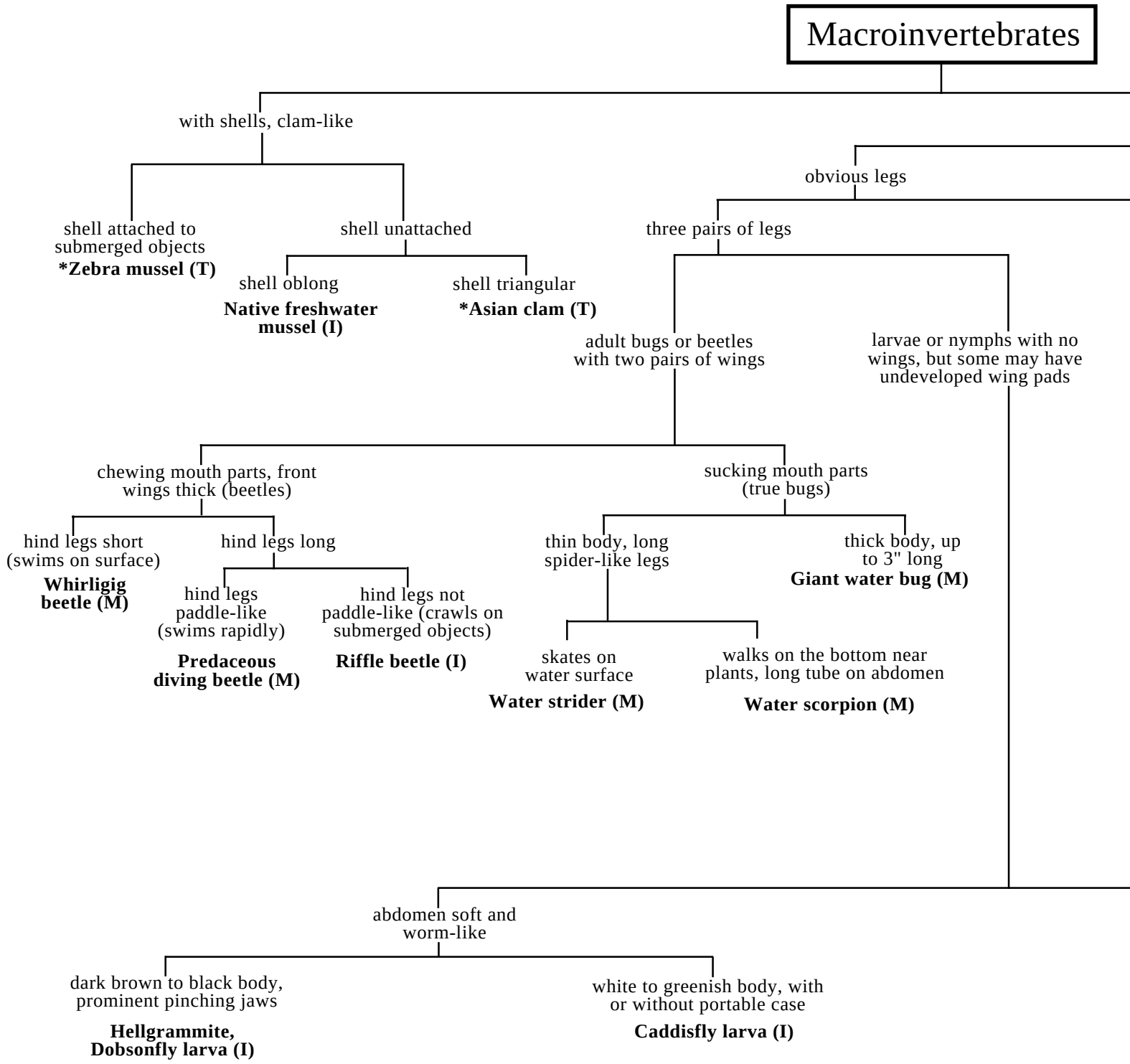
Mayfly nymph (I)

two tails, no gills on abdomen



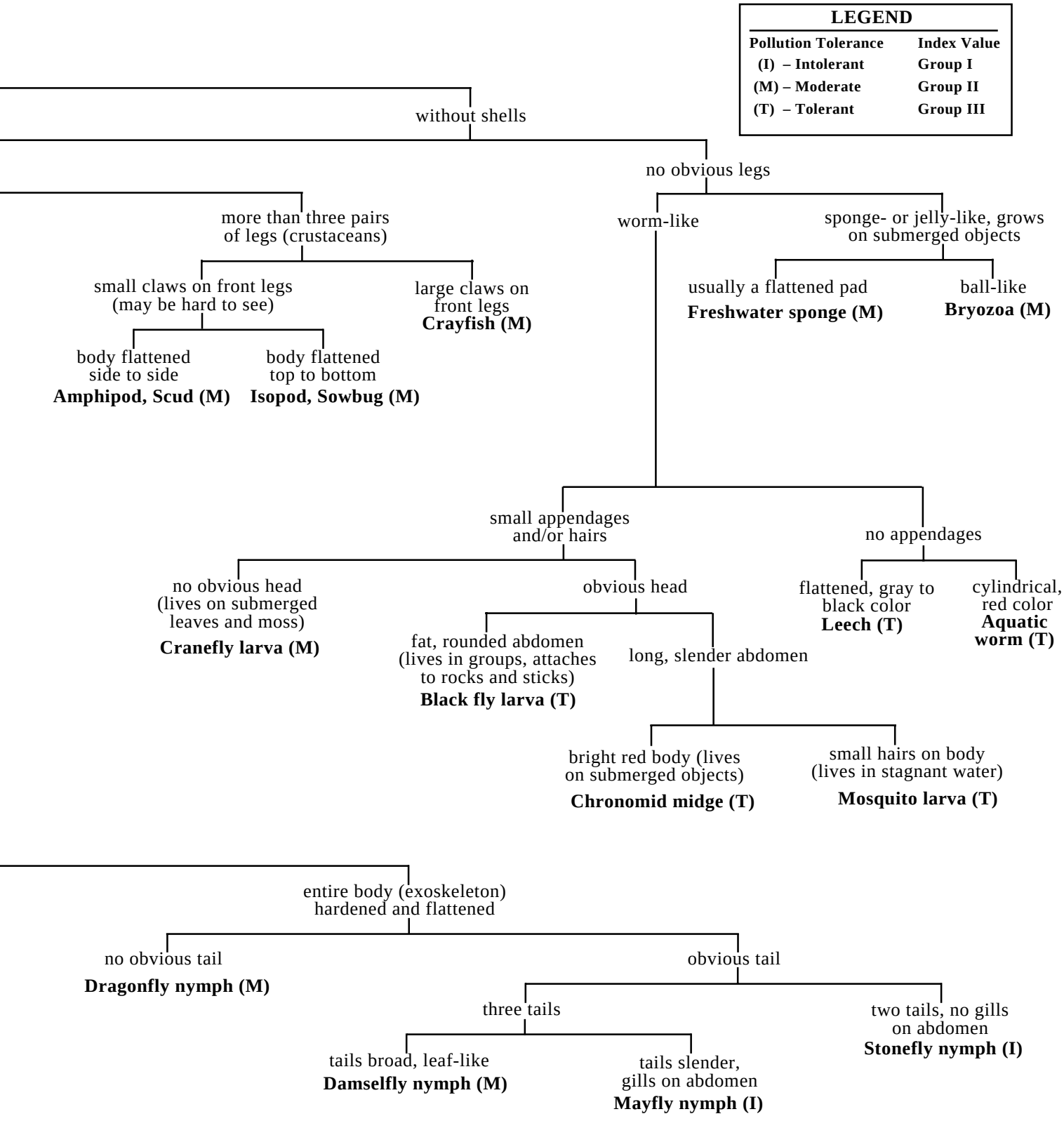
Stonefly nymph (I)

Word Key to Aquatic Macroinvertebrates

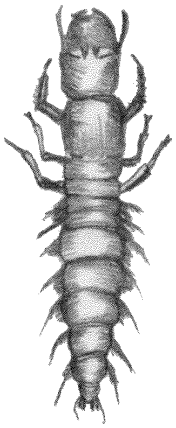


** Non-native nuisance species. The zebra mussel is not yet known in North Carolina. It is moving into the southern states. Report its occurrence to park, wildlife or Duke Energy authorities.*

Catawba River Watershed

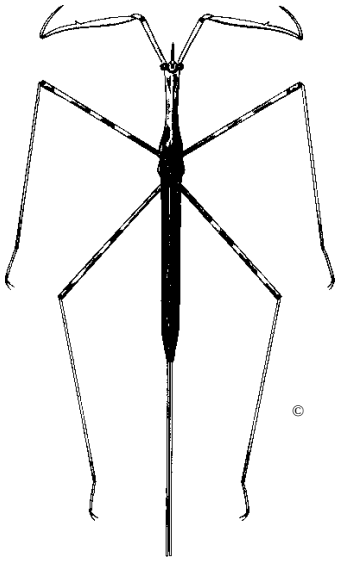


Aquatic Life Illustrations Worksheet



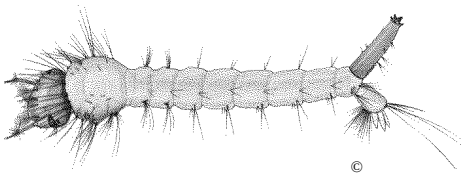
1. _____

Hints: Found on bottom under rocks; has three pairs of legs, undeveloped wing pads, soft abdomen, dark brown body and big jaws!



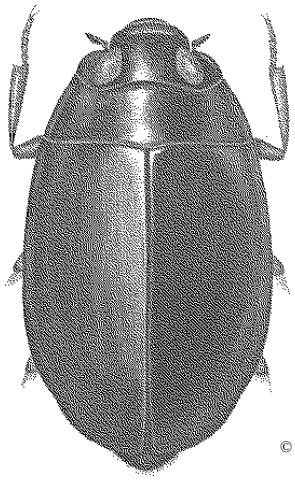
2. _____

Hints: Found on bottom near plants; has three pairs of legs, two pairs of wings and sucking mouth parts.



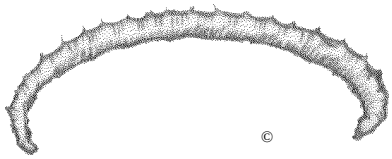
3. _____

Hints: Found near surface of stagnant water; has a definite head, slender abdomen and small appendages.



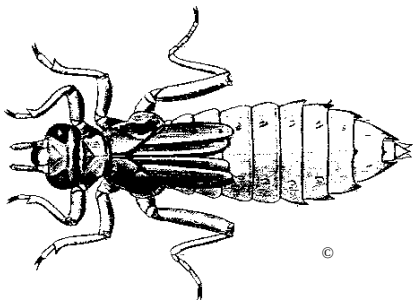
4. _____

Hints: Found swimming on surface of water; has three pairs of legs, two pairs of wings and chewing mouth parts.



5. _____

Hints: Found on bottom; has a red color, cylindrical shape, and no legs or other appendages.



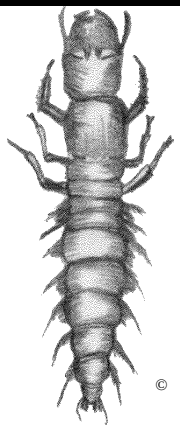
6. _____

Hints: Found on bottom; has three pairs of legs, undeveloped wing pads, hard and flat body, and no obvious tail.

Which of the above organisms is / are tolerant of pollution? _____

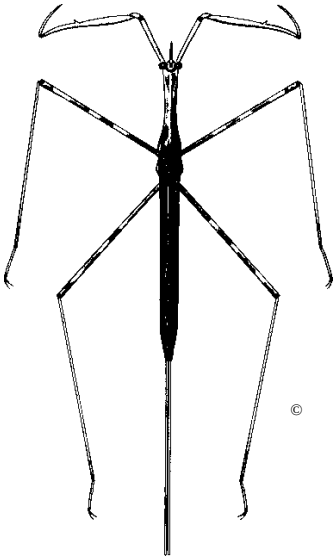
Which of the above organisms is / are intolerant of pollution? _____

Aquatic Life Illustrations Worksheet – Answers



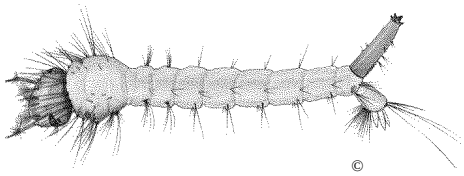
1. *Hellgrammite or dobsonfly larva*

Hints: Found on bottom under rocks; has three pairs of legs, undeveloped wing pads, soft abdomen, dark brown body and big jaws!



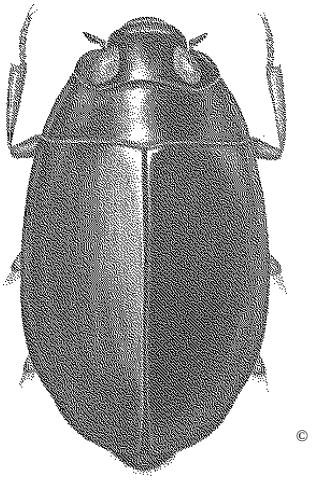
2. *Water Scorpion*

Hints: Found on bottom near plants; has three pairs of legs, two pairs of wings and sucking mouth parts.



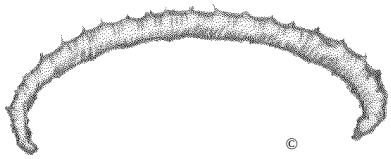
3. *Mosquito larva*

Hints: Found near surface of stagnant water; has a definite head, slender abdomen and small appendages.



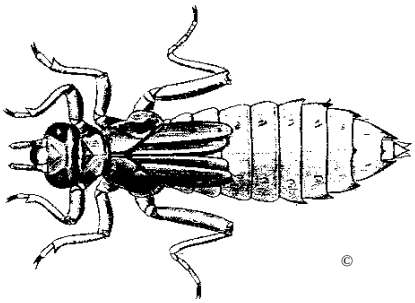
4. *Whirligig beetle*

Hints: Found swimming on surface of water; has three pairs of legs, two pairs of wings and chewing mouth parts.



5. *Aquatic worm*

Hints: Found on bottom; has a red color, cylindrical shape, and no legs or other appendages.



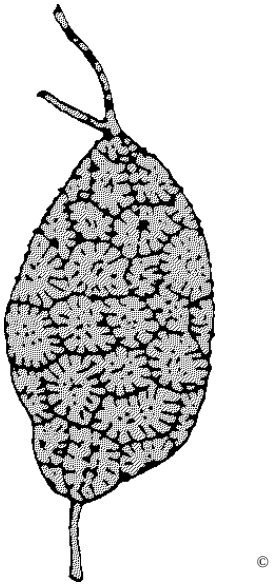
6. *Dragonfly nymph*

Hints: Found on bottom; has three pairs of legs, undeveloped wing pads, hard and flat body, and no obvious tail.

Which of the above organisms is / are tolerant of pollution? *Mosquito larva and aquatic worm*

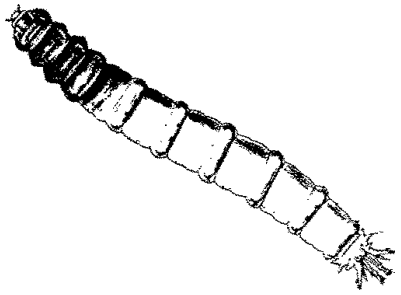
Which of the above organisms is / are intolerant of pollution? *Hellgrammite or dobsonfly larva*

Test for Key It Out



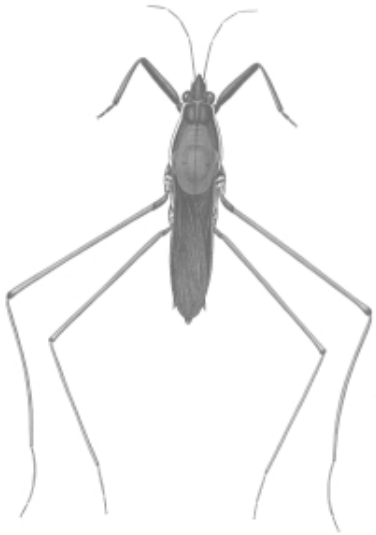
1. _____

Hints: Found attached to a stick under the water; looks like a large blob of jelly.



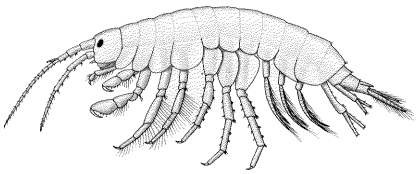
2. _____

Hints: Found on bottom under dead leaves; has no obvious head or legs.



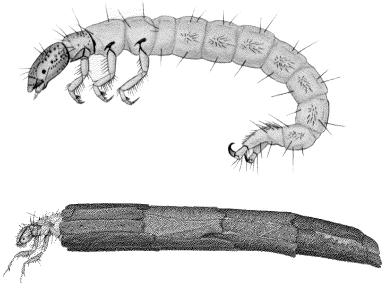
3. _____

Hints: Found on water surface; has two pairs of wings, three pairs of legs and sucking mouth parts.



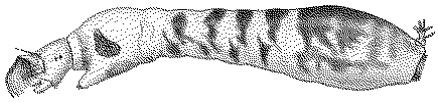
4. _____

Hints: Found swimming in dead leaves underwater; has a body flattened from side to side.



5. _____

Hints: Usually found on bottom inside a case; has three pairs of legs and a soft abdomen, and is green in color.



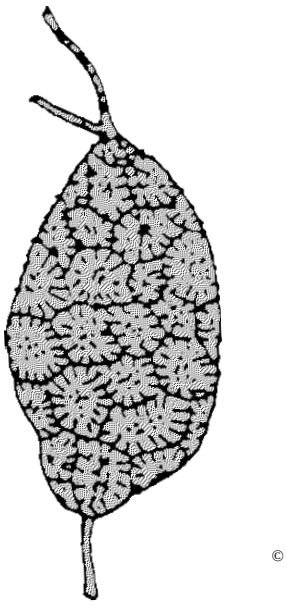
6. _____

Hints: Several found together, attached to submerged sticks; has a head and small appendages but no legs.

Which of the above organisms is / are tolerant of pollution? _____

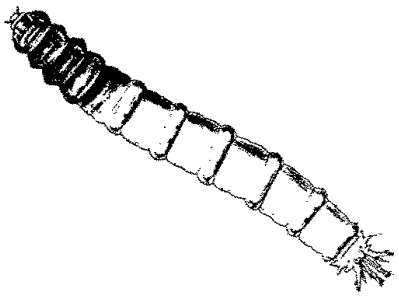
Which of the above organisms is / are intolerant of pollution? _____

Test for Key It Out – Answers



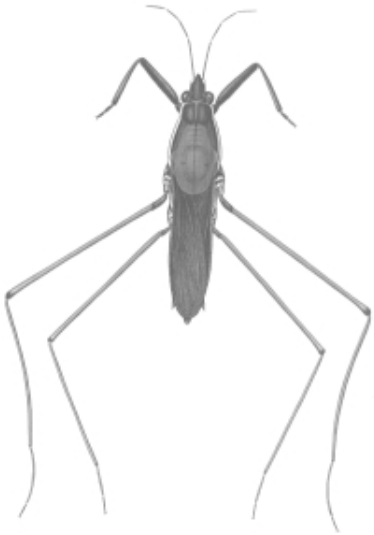
1. *Bryozoa*

Hints: Found attached to a stick under the water; looks like a large blob of jelly.



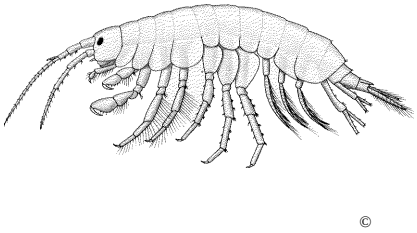
2. *Cranefly larva*

Hints: Found on bottom under dead leaves; has no obvious head or legs.



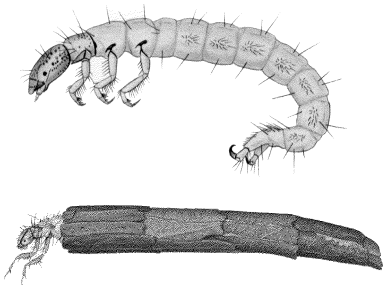
3. *Water strider*

Hints: Found on water surface; has two pairs of wings, three pairs of legs and sucking mouth parts.



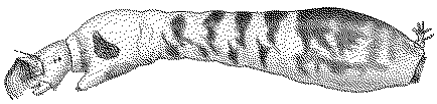
4. *Amphipod or Scud*

Hints: Found swimming in dead leaves underwater; has a body flattened side to side.



5. *Caddisfly larva*

Hints: Usually found on bottom inside a case; has three pairs of legs and a soft abdomen, and is green in color.



6. *Black fly larva*

Hints: Several found together, attached to submerged sticks; has a head and small appendages but no legs.

Which of the above organisms is / are tolerant of pollution? *Black fly larva*

Which of the above organisms is / are intolerant of pollution? *Caddisfly larva*

Pre-Visit Activity #2 Picture This

Major Concepts:
- Water
- Water cycle
- Water quality
- Watershed

Learning Skills:
- Communicating
- Recognizing key words
- Creating visual representations of concepts

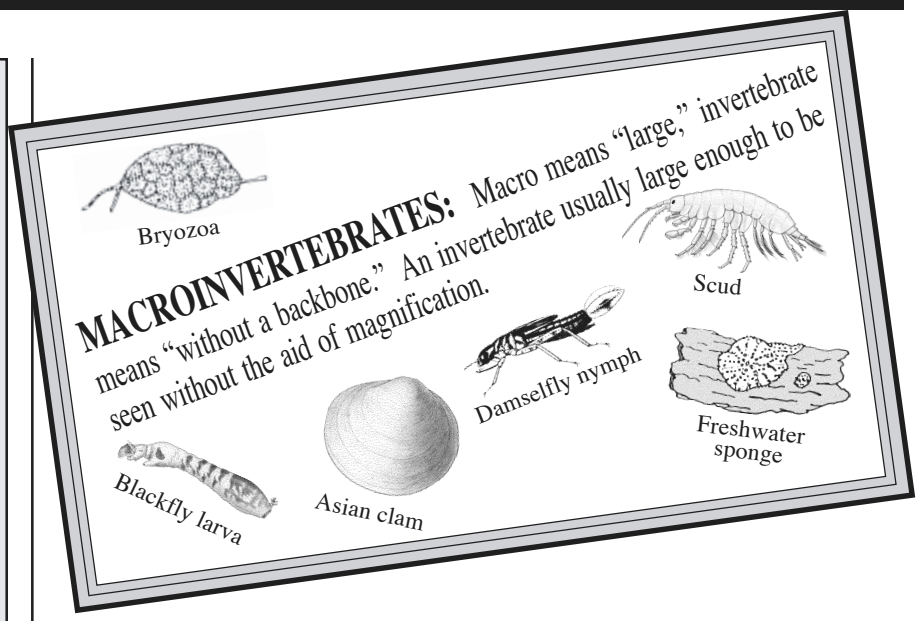
Subject Areas:
- Science
- English Language Arts
- * See the Activity Summary for a correlation with the DPI objectives in these subject areas.

Location: Classroom

Group Size: Class size

Time:
1-2 hours for poster creation, 1 hour for presentations

Materials:
Provided by the educator:
Per class: Dictionary; encyclopedia; science textbook; shoebox; assorted environmental/agricultural/travel magazines; assorted colors of markers, crayons or pencils; assorted colors of construction paper
Per student: One sheet of posterboard (assorted colors), scissors, paste or glue, sheet of paper, pencil

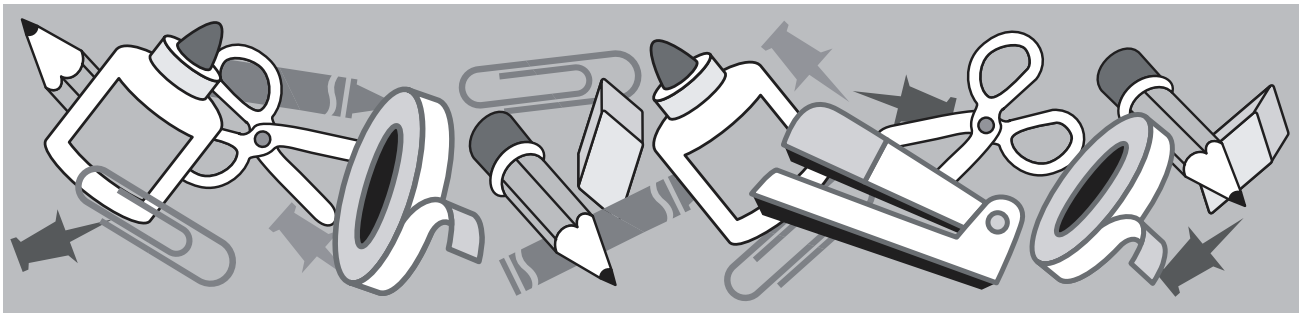


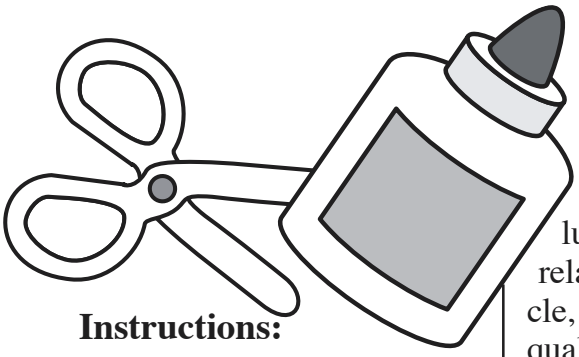
Objectives:

- Define the terms water, water cycle, watershed and water quality.
- Illustrate an aquatic vocabulary word and explain its meaning to other students.

Educator's Information:

The purpose of this activity is to familiarize students with as many water-related words as possible. The following words, found in the vocabulary section of the EELE, are especially critical as they will be used during the on-site activities at the park: **algae**, **aquatic index**, **classification**, **detritus**, **dissolved oxygen**, **effluent**, **genus**, **groundwater**, **impervious surface**, **indicator species**, **key, larva**, **macroinvertebrate**, **metamorphosis**, **mussel**, **nymph**, **pH**, **runoff**, **sediment**, **silt**, **taxonomy**, **tributary**, **wastewater treatment plant**, **water**, **water cycle**, **water quality**, **watershed**. The students should *not* memorize the definitions, but they should know how to use the words correctly in a sentence. The goal is for students to relate these words and concepts to their everyday experiences with water.

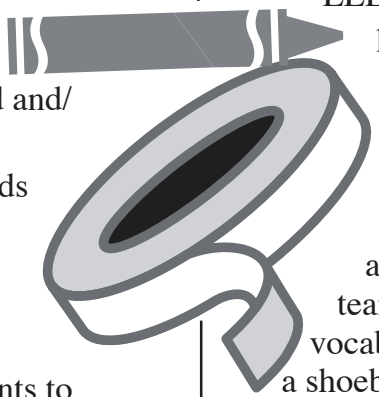




Instructions:

1. Write **aquatic** vocabulary words on separate pieces of paper or index cards. You will need one word for each member of the class. Be sure to use the words listed in the Educator's Information. Add more words, if needed, from the vocabulary section of the EELE.

2. Read and/or discuss the Student's Information with the class. Tell the students that each of them will be receiving a vocabulary word related to water. They will be using these vocabulary words during their activities at Lake Norman State Park. Their task will be to design a poster that shows how their word is related to water, water cycle, watershed and/or water quality.



3. Place the words in a shoebox and ask each student to take one word.

4. Instruct students to develop a definition for their word using a dictionary, the EELE vocabulary section, science textbook, encyclopedia and/or other reference books. They should write their word and its definition somewhere on their poster. They can do their own artwork or use magazine pictures to illustrate how their word is related to water, water cycle, watershed and/or water quality.

5. Have each student present his/her word to the class by reading the definition and displaying the poster. Turn your classroom and/or hallway into a gallery of water-related art. The posters will serve as visual reminders of important concepts and will help promote water quality awareness to other students in the school.

Assessment:

1. Give a vocabulary test.

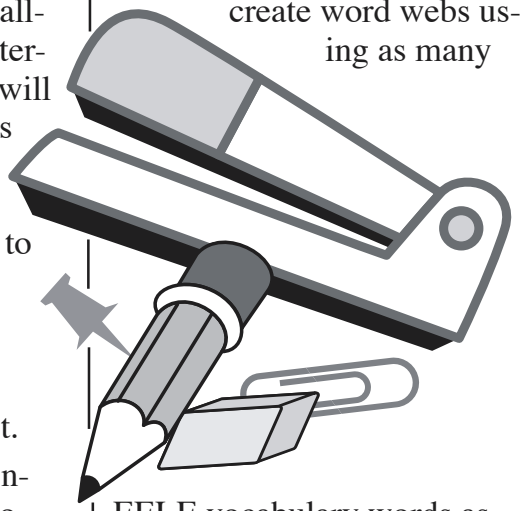
2. Have a vocabulary contest. Divide students into teams. Write all of the vocabulary words in the EELE on separate pieces of paper and place them in the shoebox. Use the words to play "Pictionary" in which one team member pulls a vocabulary word from a shoebox and draws a picture(s) to illustrate the word. Fellow team members must guess the correct word within 30 seconds or other teams can guess to "steal" a point. For another game, have one student from each team face off with another to see which team can define the most words the fastest on paper.

Suggested Extensions:

1. Create vocabulary flash cards.

2. Create a vocabulary word search or crossword puzzle.

3. Instruct student teams to create word webs using as many EELE vocabulary words as possible. Provide each team with a copy of the vocabulary section of this EELE. Other related words could be included as well.



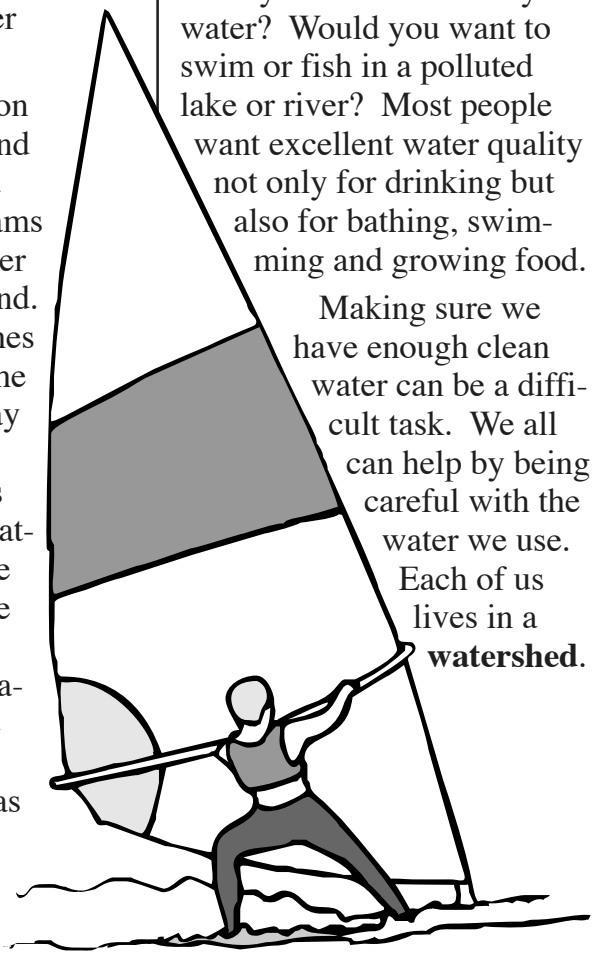
4. Have a student team act out a vocabulary word. Other teams watch the skit. After 30 seconds, each team turns in their guess written on a slip of paper. Each team that guesses correctly gets one point. The performing team gets one point if one or more of the other teams guesses the word correctly. If none of the other teams are able to correctly identify the vocabulary word, the performing team does not score a point.

Student's Information

Water is central to all life and life's activities, including reproduction and growth! Plants and animals must have water to survive. Water represents about 75 percent of a person's body weight and covers nearly 75 percent of the Earth's surface. Nearly everything on Earth can be directly or indirectly traced to a connection with water, or is involved in the **water cycle**. Even the driest desert contains water. It is easy to see why scientists call Earth the "water planet."

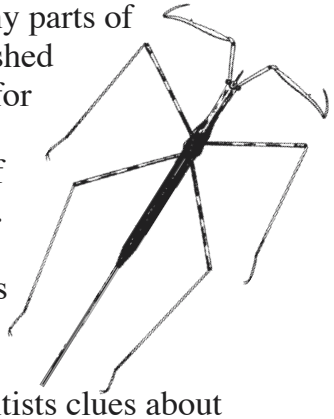
Water is always on the move. Rocks and **soil** filter water and channel it into streams and rivers both under and above the ground. Ponds, lakes, marshes and swamps slow the water down and may hold it for awhile. But water is always escaping by evaporating from the surface and floating into the air. Clouds carry large amounts of water vapor across the sky until the water falls back to Earth as rain, sleet or snow. Even the glaciers, our planet's largest freshwater storage tanks, are constantly moving, melting and changing shape.

Although water is constantly recycling, this doesn't mean it will always be available for our use. Fresh water may be scarce in some places and abundant in others. Sometimes water becomes polluted or poisoned and is difficult to clean. Care must be taken to protect our water resources, especially their **water quality**. Would you want to take a shower or wash your clothes in dirty water? Would you want to swim or fish in a polluted lake or river? Most people want excellent water quality not only for drinking but also for bathing, swimming and growing food.



Making sure we have enough clean water can be a difficult task. We all can help by being careful with the water we use. Each of us lives in a **watershed**. A watershed is the total land area that drains into a particular river, lake or stream. If we pollute the water in one part of the watershed, the water quality in the rest of the watershed will be affected. Some people use bodies of water as places to dump trash. This not only affects the water, but it can hurt the other people and the wildlife that live in that watershed.

Scientists manage the water quality of a lake, such as the lake at Lake Norman State Park, by studying its watershed. They test the water in many parts of the watershed and look for possible sources of **pollution**. The kinds of animals living in the water give scientists clues about water quality. Some **insects** and other **macroinvertebrates** can only live in water that is very clean. If these animals are present, they indicate good water quality. When you visit the park, you will have the opportunity to study the water quality and explore the watershed. You may even discover new ways to improve the water quality in the park's watershed.



Pre-Visit Activity #3 River Roots

Major Concepts:
- Watersheds
- Topographic maps

Learning Skills:
- Communicating, measuring, inferring and predicting
- Reading and interpreting topographic maps
- Measuring and estimating
- Working effectively in groups

Subject Areas:
- Science
- Social Studies
- Mathematics
- English Language Arts

* See the Activity Summary for a correlation with the DPI objectives in these subject areas.

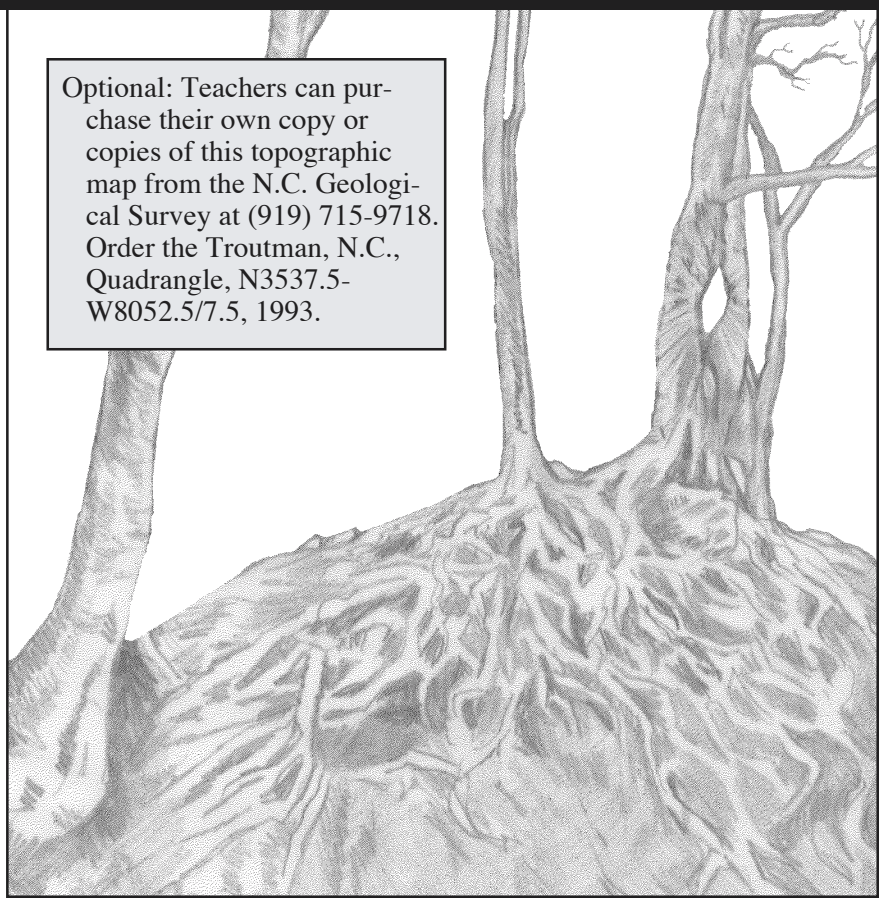
Location: Classroom

Group Size: 30 or smaller in groups of 5 or less

Estimated Time:
1 to 1 1/2 hours

Materials:
Provided by the park upon request:
Per educator: One U.S. Geological Survey (USGS) topographic map, already colored, that will serve as the answer key
Per group: One laminated USGS topographic map of Troutman, N.C., Quadrangle; set of overhead projector pens (colors: red, green, blue and black)
Provided by the educator:
Per group: Ruler and one copy each of Supplementary and Topo Enlargement
Per student: River Roots Worksheet, pencil

Optional: Teachers can purchase their own copy or copies of this topographic map from the N.C. Geological Survey at (919) 715-9718. Order the Troutman, N.C., Quadrangle, N3537.5-W8052.5/7.5, 1993.



Objectives:

- Use a legend to identify common symbols on a topographic map such as the symbols for a creek, permanent structure, forested area and open area.
- Correctly locate specific geographic features on a topographic map such as rivers, mountains and watersheds.
- Use a map scale to estimate distances on a topographic map, and read contour lines to estimate elevations.
- Draw inferences from a topographic map regarding human activities and their possible effects on specific watersheds.

Educator's Information:

This activity is designed to help students understand the concept of **watersheds** and to become familiar with the park lake watershed. Using a topographic map, students will outline the watershed; identify creeks, roads and structures within it; and answer various questions concerning possible influences on the park lake's **water quality**. Students will participate in groups to complete the worksheet.

Familiarize students with the EELE vocabulary before doing this activity. You might use Pre-Visit Activity #2, "Picture This."

Instructions:

1. Distribute one copy of the Student's Information to each student. Read and discuss this information. Make sure students understand the vocabulary words in bold print.

2. Guided Practice: Divide students into groups of five students or less. Give each group one copy of the Topo Enlargement, which is a section of a topographic map (page 3.3.10). Use the Topo Enlargement to show the students how to identify watersheds and other geographic features on a topo map.

3. Pass out the topographic map of the Troutman Quadrangle and the Supplementary (page 3.3.9). Point out the map legend and north arrow. Use the Supplementary to teach the students about other symbols commonly used on topographic maps. You may also wish to show students how to estimate distances using the map scale, how to estimate elevation by reading contour lines and how to calculate the area of a triangle. (Pass out the rulers at this time if you are doing a measuring practice; otherwise wait until step 4, below.)

4. Distribute a ruler, a set of overhead projector pens and the River Roots Worksheet to each group. Each student should do one of the exercises under part A of the worksheet. Caution students to use only the projector pens provided when working on the laminated topographic maps. Permanent ink will ruin the maps. Students should use their own pencils when answering questions on the worksheet. We recommend that the students work together on part B, but each student should fill out his/her own copy of the worksheet.

5. Review the worksheet answers with the students. Discuss the following questions as a class:

A. What are some of the ways people are using the **water** in the park lake watershed? (Answers: recreation, diluting wastewater, **irrigation** for crops and a water source for livestock, and domestic uses).

B. As rain, snow and other **precipitation** fall on the park lake watershed, what do they come in contact with? (Answers: forests, fields, roofs, roads, parking lots, lawns, etc.)

C. What types of pollutants might the precipitation pick up as a result of these contacts? (Answers: fertilizers, **soil**, **silt**, animal wastes, etc., from fields and lawns; petroleum products like oils, tar, gas and automotive fluids from roofs, roads and parking lots; etc.)

D. Identify less obvious ways the watershed community might pollute the waters. (Answers: overflowing **sewage** systems, air **pollution** such as **acid rain**, leaking underground storage tanks, etc.)

E. How can the watershed community prevent polluted **runoff** and protect the waters? (Answers: farmers could use **erosion** control methods such as silt fences, terraces and catchment basin ponds, as well as reduce use of fertilizers and pesticides; homeowners could reduce use of fertilizers and pesticides on lawns and gardens and maintain cars and **septic systems** properly; landowners could maintain forests and/or stabilize soils by other methods; etc.)

5. Enlist student help to remove the pen marks from the topographic maps. Use only water and a damp sponge or soft cloth. Return the maps to the park within two weeks.

Assessment:

Conduct this same activity for your school's watershed, or for a watershed in another county. (This will necessitate purchasing additional quadrangle maps. Laminate the maps so that they can be used again.) Compare watersheds in terms of the natural and human communities, possible sources of pollution and the geology of the watersheds.

Suggested Extensions:

1. Have students create posters illustrating the effects of watershed pollution. They should show how pollutants in one part of the watershed can migrate to other parts, and even to different watersheds in the same **river basin**. How might pollution affect wildlife and people?

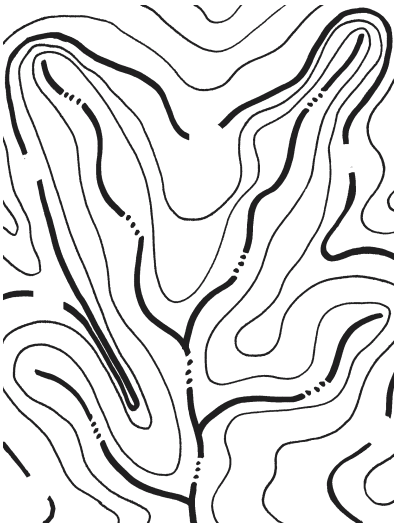
2. Using maps of the Catawba River Basin, have students trace the flow of water from its headwaters to the South Carolina state line. These maps are available from: Stream Watch Coordinator, N.C. Division of Water Resources, 1611 Mail Service Center, Raleigh, NC, 27699-1611, (919) 733-4064. Order the Upper and Lower Basin maps. A map and a chart of vital statistics of the Catawba River Basin can also be found on the Division of Water Quality website at:

http://h2o.enr.state.nc.us/basinwide/basin_maps.htm

Student's Information

Each of us lives in a **watershed**. One way to picture a watershed is to think of a mountain valley. Imagine you are standing at the bottom of the valley, near a river. Looking up, you can see high ridges all around you. These ridges are the boundaries of the watershed. Since **water** always seeks the lowest level, all the **precipitation** that falls on the ridges and slopes will eventually end up in the river at the bottom of the valley. All the land between the high ridges and the bottom of the valley is part of this watershed. Activities that occur anywhere in the watershed will affect the river's **water quality.**

In the Piedmont and Coastal Plain, the land slopes more gradually to a river or lake. Although the watersheds aren't as obvious as those in the mountains, they do exist. One way to picture a watershed in the Piedmont is to look at a map. Find a river and its **tributaries**. If you think of the river as a giant tree and the tributaries as the tree's roots, all the land surrounding the "roots" is a part of this watershed. Whatever happens in the river's roots affects the entire river. The large watershed of a river is often referred to as a **river basin.**



Watersheds are naturally self-destructive. The creeks or rivers that shape the watershed gradually erode the land. Human actions such as land clearing, dam building, farming, water diversion and industrial development can speed up this natural process. If not carefully done, these activities can loosen the **soil**, allowing excessive amounts of **sediment** to run into the creeks and tributaries of the watershed. The sediments fill stream channels and harbors, and suffocate fish and other **aquatic** animals by clogging their gills.

People can harm a watershed in other ways. When it rains, fertilizers (sometimes called nutrients) run off farm fields and lawns into the water. Nutrients can also enter the watershed from **wastewater treatment plants** and **septic systems**. Fertilizers cause large amounts of **algae** to grow, creating an **algae bloom**. The algae die after they have used all the nutrients. As bacteria decompose the dead algae, they use up the oxygen in the water that fish and other aquatic animals need to breathe. A fish kill may result. Fertilizer can also cause aquatic weeds to grow, clogging streams and ponds. This deadly process, known as **eutrophication**, greatly reduces the water quality.

Other pollutants such as chemicals from industry, pesticides used in agriculture, and motor oil from cars can cause problems in a watershed. Many chemicals are poisonous to wildlife and people. Aquatic animals are especially vulnerable. Chemicals in one part of a watershed can work their way to other parts. One serious **pollution** event can damage aquatic **food chains** in the watershed for many years.

It is important to realize that although we can study individual watersheds, the watersheds are actually connected to one another. For example, a river basin contains the smaller watersheds of all the river's tributaries. If one of these smaller watersheds becomes contaminated, it will eventually affect the watersheds downstream. As water flows downstream to the ocean, contaminants can accumulate and cause great damage to the lower part of the river basin.

In this activity, you will use a topographic map to study the park lake watershed. This small watershed connects with the larger watershed of Lake Norman that, in turn, is part of the Catawba River Basin. You will look at human activities in the park lake watershed and possible sources of pollution. When you visit Lake Norman State Park, you will be able to explore the watershed firsthand.

River Roots Worksheet

Name:_____

A. Exercises: Use only the projector pens provided.

1. Locate Lake Norman State Park and trace its boundary with the green pen.
2. Locate the park lake and outline it with the blue pen. (Note: The park lake is part of the Norwood Creek watershed and is separated from Lake Norman by an earthen dam.)
3. Trace all of the creeks, branches and tributaries that empty into the park lake with the blue pen.
4. Trace the boundary of the park lake watershed with the red pen using the nearest roads as a general outline.
5. Identify and count all structures within the watershed by striking through them with the black pen.
6. Trace all light-duty roads within the watershed with the black pen.

B. Questions:

1. Lake Norman State Park is located near what town?

   _____

2. In what county is the park located?

   _____

3. What is the only neighboring county listed on the map?

   _____

4. Count all of the named creeks and branches that empty into the park lake. How many are there? _____ List the names:

   _____

   _____

5. Using the scale at the bottom of the map, estimate the length of each of these named creeks and branches in miles. Also add them together for a total.

   _____

   _____

6. In addition to these larger creeks/branches, a number of unnamed streams and branches feed the park lake. Approximately how many are there?

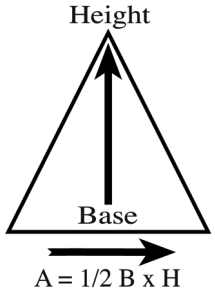
   _____

7. Knowing that the watershed is in the shape of a triangle (roughly), determine its approximate area in square miles by using the following formula:

   Area of a triangle = 1/2 base x height

   _____

   Find other ways to estimate the watershed area, such as by using a grid.



8. Is most of the watershed forests or fields?

_____

9. Besides the park, what large educational facility lies within the watershed?

_____

10. Approximately how many structures/buildings lie within the watershed?

_____

11. Using the scale and road classification key at the bottom of the map, estimate how many miles of light-duty roads lie within the watershed.

_____

12. Into what large body of water does the park lake's water flow?

_____

13. Before the park lake's water reaches the main body of Lake Norman, into what portion of the lake does it empty?

_____

14. What river was dammed to form Lake Norman?

_____

15. In what compass direction do most of the park lake's tributaries flow?

_____

16. Calculate the change in elevation from park lake to the highest point in the watershed.

_____

17. Name some possible sources of pollution in the park lake watershed. Then describe the type(s) of pollutant that each source might contribute.

Source	List or Describe the Water Pollution
ex: road	*oil and other chemicals from cars*

River Roots Worksheet (Answers)

A. Answers to Exercises:

1. Locate Lake Norman State Park and trace its boundary in green.
2. Locate the park lake and outline it with the blue pen. (Note: the park lake is part of the Norwood Creek watershed and is separated from Lake Norman by an earthen dam.)
3. Trace all of the creeks, branches and tributaries that empty into the park lake with the blue pen.
4. Trace the boundary of the park lake watershed with the red pen using the nearest roads as a general outline.
5. Identify and count all structures within the watershed by striking through them with the black pen.
6. Trace all light-duty roads within the watershed with the black pen.

(See 1993 version of Topographic Map for answers to Exercises 1-6.)

B. Answers to the Questions:

1. Lake Norman State Park is located near what town?
   Troutman, N.C.

2. In what county is the park located?
   Iredell

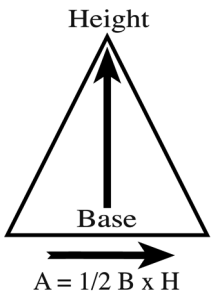
3. What is the only neighboring county listed on the map?
   Catawba

4. Count all of the named creeks and branches that empty into the park lake. How many □are there?**Three**. List the names:
   Norwood Creek, Bass Creek, Powder Spring Branch

5. Using the scale at the bottom of the map, estimate the length of each of these named creeks and branches in miles. Also add them together for a total.
   Norwood Creek: 4 miles, Powder Spring Branch: 3 miles, Bass Creek: 1 mile
   Total: 8 miles

6. In addition to these larger creeks/branches, a number of unnamed streams feed the park lake. Approximately how many are there? ***25***

7. Knowing that the watershed is in the shape of a triangle (roughly), determine its approximate area in square miles by using the formula:



Area of a triangle = 1/2 base x height

Area of watershed = 1/2 (4 miles x 5 miles) = approx. 10 sq. miles

8. Is most of the watershed forests or fields?
   Approximately equal
9. Besides the park, what large educational facility lies within the watershed?
   South Iredell High School
10. Approximately how many structures/buildings lie within the watershed?
    400
11. Using the scale and road classification key at the bottom of the map, estimate how many miles of light-duty road lie within the watershed.
    18
12. Into what large body of water does the park lake's water flow?
    Lake Norman
13. Before this water reaches the main body of Lake Norman, into what portion of the lake does it empty?
    Hicks Creek
14. What river was dammed to form Lake Norman?
    Catawba River
15. In what compass direction do most of the park lake's tributaries flow?
    South
16. Calculate the change in elevation from park lake to the highest point in the watershed.
    See the intersection of SR 1333 and SR 1004:
    980 ft. - 760 ft. = 220 ft. change in elevation
17. Name some possible sources of pollution in the park lake watershed. Then describe the type(s) of pollutants that each source might contribute.

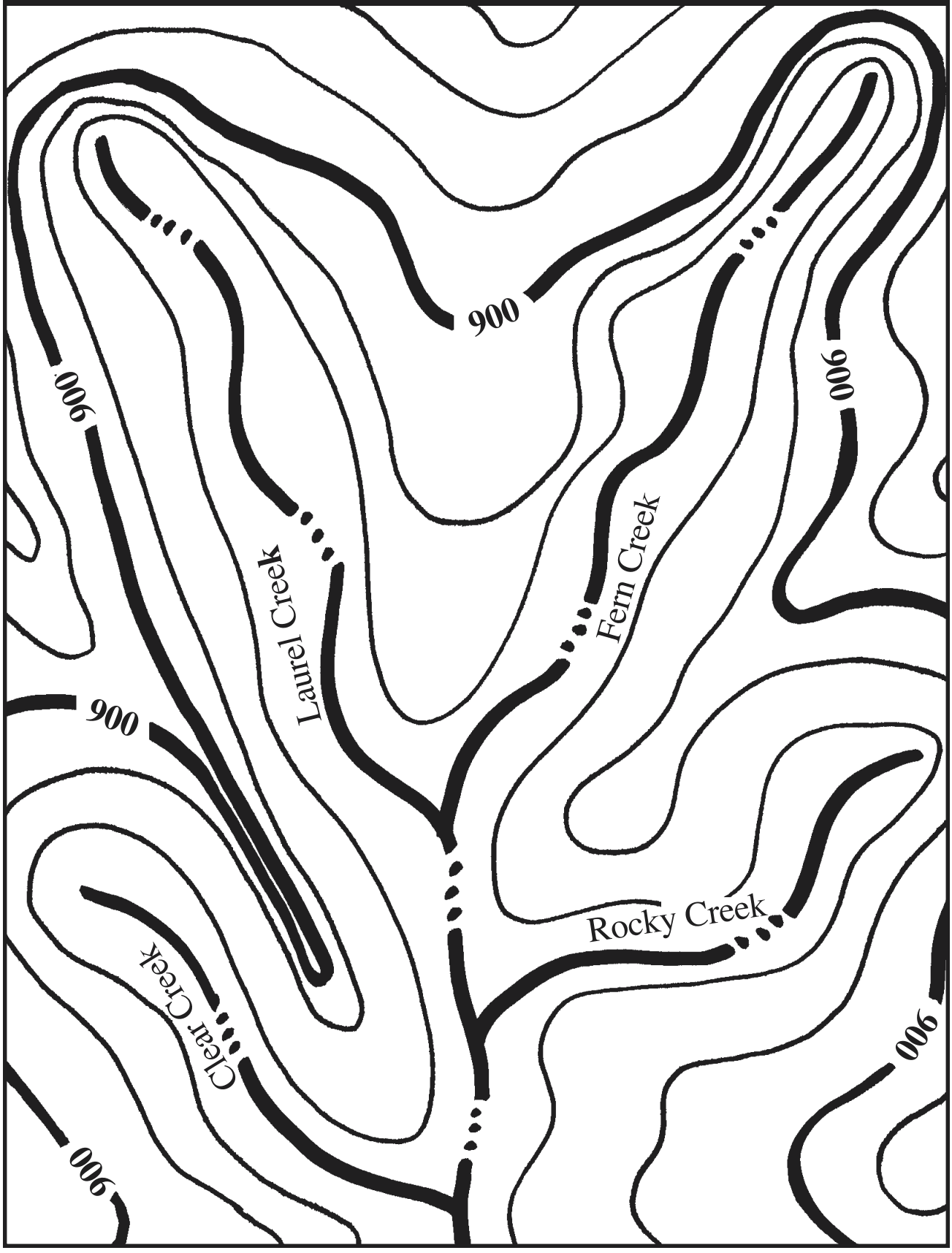
Source	List or Describe the Water Pollution
ex: road	*oil and other chemicals from cars*
homes	***treated sewage***
gas stations	***gasoline from leaky storage tanks***
logging operations	***runoff – sediment***
boaters and picnickers	***litter***
housing developments	***runoff – sediment, fertilizers, pesticides***
farms	***fertilizers, animal waste, pesticides, herbicides***
industry	***chemicals, dyes***

Supplementary USGS Topographical Map

Symbols and Legends

Symbol(s)	Description
	Type of permanent structure
	Stream, creek or other flowing water
GREEN AREA	Forested area
	Open area (i.e. fields, lawns, etc.)
	Park boundary

Topo Enlargement



On-Site Activity #1 Life at the Bottom

Major Concepts:
- Water quality
- Aquatic sampling
- Indicator species
- Aquatic habitats
- Species identification
- Macroinvertebrate external anatomy and adaptations

Learning Skills:
- Observing, classifying and communicating
- Interpreting data and making inferences
- Sampling and calculating aquatic index values

Subject Areas:
- Science
- English Language Arts
- Mathematics
- Math: measurement

* See the Activity Summary for a correlation with the DPI objectives in these subject areas.

Location:
Park lake shoreline and tributaries (Contact park staff for best location.)

Group Size:
30 or fewer in groups of 5 or less

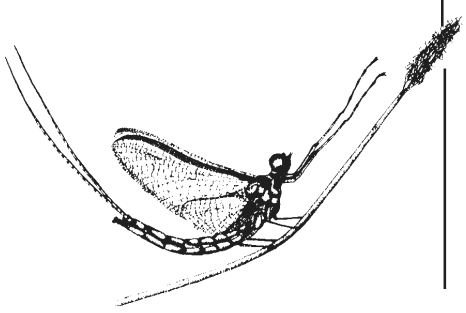
Estimated Time: One hour

Appropriate Season:
Spring, summer, fall

Credits:
Adapted from *A Field Manual for Water Quality Monitoring, an Environmental Education Program for Schools* by Mark K. Mitchell and William B. Stapp.

Materials:
Provided by park:
Per student: Life jacket
Per group: Kick net, seine net, dip net, plastic cups, aquarium or white tray, dissecting scope, magnifying glass, tweezers or plastic spoons, field guides, table, laminated aquatic macroinvertebrate key, rubber gloves, extra activity sheets, examples of adult macroinvertebrates
Per class: Throw rope
Provided by educator:
Per student: One copy of Student's Information and Calculating the Aquatic Index Value
Per group: Pencil, clipboard, Aquatic Sampling Worksheet, Picture Key to Aquatic Macroinvertebrates – Catawba River Watershed
Per school: First aid kit

Special Considerations:
Carry rescue throw rope. It is recommended that all students wear life jackets during this activity. Students should wear gloves when sorting samples. Handle organisms carefully so that they are not harmed, and return them to the water after the activity. Before the activity, advise students of appropriate dress (i.e. old shoes without holes in them, old jeans, etc.) Make sure participants bring a complete change of clothes.



Objectives:
- Describe three characteristics of an aquatic macroinvertebrate.
- Key out and identify three macroinvertebrates in the field.
- Calculate the aquatic index value and aquatic index rating for a body of water.
- List three or more ways humans can affect aquatic life.

Educator's Information:

In lakes and other **aquatic** environments, the presence or absence of certain **organisms**, called **indicator species**, reveals much about the **water quality**. The creatures that live in the water can help us calculate an **aquatic index**, which tells us the relative health of a water body.

Water with a rich and varied range of aquatic species is usually a healthy environment. Water with only a few species usually indicates less healthy conditions. *Healthy* is used here to mean an environment supportive of life. **Pollution** generally reduces the quality of the environment and, in turn, the diversity of life. In some cases, the actual biomass, or amount of living material, *increases* due to pollution,

McCafferty: *Aquatic Entomology*.
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while the diversity of species *decreases*.

The major purpose of this activity is to help students recognize indicators of water quality in the park lake and other aquatic **habitats**. The students will work in groups to collect and identify **macroinvertebrates** in the lake.

Students must be dressed appropriately. It is recommended that all students wear life jackets, provided by the park, during this activity. Bring a first aid kit from your school, if possible. Educators who have not taken an EELE workshop at the park should visit the park and discuss safety considerations with the park staff before the class' visit. The educator is responsible for seeing that all safety precautions are followed.

In preparation for their visit to the park, students should complete Pre-Visit Activity #1, "Key It Out." Also, read and discuss the Student's Information and Calculating the Aquatic Index Value, found in this onsite activity. Ask students to reflect on how the macroinvertebrates they find in the park lake will help them determine the water quality.

Instructions:

1. At the park, the educator should stop at the park office for assistance in locating the equipment provided by the park. Before beginning the sampling at a site determined by the park staff, the educator should conduct a brief review focusing on: macroinvertebrates, what they are and why they are important; **metamorphosis**, what it is and how it is accomplished; and indicator species, what they are and how they are used to determine the health of the lake.

2. Demonstrate the use of the dip, seine and kick nets.

a. When using a seine or kick net, spread the sample out evenly over the net. Keep the net with the sample at least one inch above the ground at all times.

b. Using a plastic cup, carefully pour water over the sample to wash away debris.

3. Demonstrate the technique of sample analysis.

a. Fill an aquarium or white tray halfway with water.

b. Carefully search the cleaned sample for macroinvertebrates. You may need to use a magnifying glass.

c. With tweezers or plastic

spoons, carefully remove the organisms and place them in the aquarium or tray.

d. Place the aquarium or tray on the table for observation/identification. Use field guides, the laminated macroinvertebrate **key**, the examples of adult macroinvertebrates and dissecting scopes to identify the organisms.

Note: Remind your students that the key is not complete. They should match the organisms they find as closely as possible to the pictures in the key. For example, there are 186 dragonfly species in North Carolina. The key shows only one species of dragonfly **nymph**; however, the illustration is generic enough that students should be able to successfully identify any dragonfly nymphs they find.

e. Record the macroinvertebrates by group on the Aquatic Sampling Worksheet. Calculate the aquatic index value for the lake.

f. Return all organisms to the water after completing the research.

4. Divide the class into groups of five or less. Pass out the worksheets and keys to each group leader. Ask the student groups to predict the aquatic index rating for the park lake and write their predictions under Part A on the worksheets. Next, ask the students to put on their life jackets, gather their sampling equipment and spread out to collect their samples. Observe the students to ensure they are using proper collecting techniques and following safety procedures. The groups using the nets should move to the shore to identify the macroinvertebrates found and to complete their worksheets.

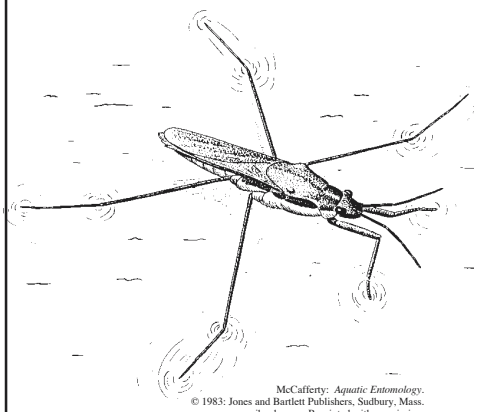
5. As time permits, allow students to observe the physical and behavioral **adaptations** of the collected macroinvertebrates. Can they see any examples of predator-prey relationships? Are any of the macroinvertebrates well camouflaged? Can students observe gills or other structures that allow the animals to breathe? Can students determine the stage of metamorphosis of each collected **insect**? Remind the students to return the animals to the water when they have finished their research.

6. Instruct the groups to clean their equipment and return it to the location where they found it.

7. Gather the whole class and have each group present its findings. According to the students, what is the aquatic index value and aquatic index rating of the park lake's water quality? How does it compare to the students' initial predictions? If the predictions and results are different, encourage students to explore reasons.

Do different groups have different results? If so, can they suggest reasons why? (Possible answers: improper collection and/or identification techniques, different habitats or bottoms may have been sampled by each group, etc.)

Finally, discuss how humans can affect aquatic life in this lake. Did the students notice any possible human impacts while they were conducting the study? (Possible answers: People can affect aquatic life by damming a river or by otherwise changing its flow. Polluted **runoff** has a major affect on aquatic life. **Soil** and chemicals washing off fields, lawns, parking lots and streets within a **watershed** can harm aquatic animals and their bottom habitats. People can also directly pollute the water by dumping their trash in it. Less obvious impacts on aquatic animals come from air pollution, such as **acid rain**, and from the introduction of non-native species, such as the Asian clam or zebra mussel.



McCafferty: *Aquatic Entomology*.

Assessment:

Use the test provided at the end of this activity, or design one of your own. Students will need one of the keys to aquatic macroinvertebrates found in this EELE to answer the test questions.

Answers for the test:

Group I: no organisms.
Group II: bryozoa, isopod (sowbug), water scorpion, dragonfly nymph, cranefly **larva**, damselfly nymph and crayfish. Total = 7.
Group III: Asian clam and mosquito larva. Total = 2.
Aquatic index value: 16 [(7 x 2) + (2 x 1) = 16].
Aquatic index rating: Fair.

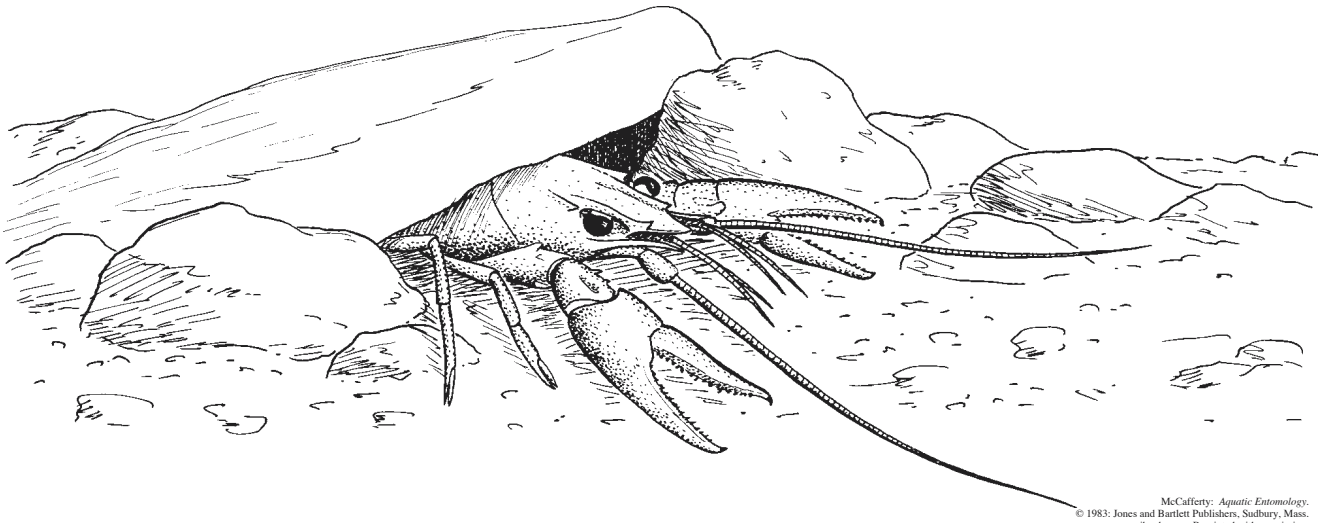
The water quality in Burns Lake is on the high end of fair. We might conclude that the health of the lake has been compromised in some way. It is interesting that there are no species from Group I, which includes species intolerant of pollution and indicates excellent water quality. See the discussion under step 7 in the Instructions for examples of how humans might be affecting Burns Lake.

Suggested Extensions:

1. Ask students to use their data from the Aquatic Sampling Worksheet to create a bar or circle graph that shows the relative numbers of macroinvertebrates from Groups I, II and III in their samples collected at the park lake. How do their graphs reflect the water quality of park lake?

2. Sample Lake Norman's bottom **sediments** and compare the results to those from the park lake. Use graphs or charts to illustrate the differences or similarities.

3. Sample different locations in park lake (i.e. below the park lake bridge, near the mouth of the creek, etc.) or in the various streams feeding the park lake. Use charts, graphs or tables to illustrate how different habitats may result in different species and different aquatic index values.



Student's Information

"*Water, Water everywhere nor any drop to drink*."

So says the sailor in Samuel Taylor Coleridge's "Rime of the Ancient Mariner" as their boat is becalmed at sea. Fortunately, in our area **water** is everywhere and there seems to be plenty to drink. But that may be changing as Lake Norman becomes more developed and is used by more people. Let's take a closer look at water and discover what a fragile and sensitive resource it is.

What is Water?

The dictionary defines water as a colorless, odorless transparent liquid occurring on Earth as rivers, lakes, oceans, etc., and falling from the clouds as rain, snow, ice, etc. Water occupies more than 70 percent of the Earth's surface, and it makes up approximately 60 percent of the human body. You may have heard the saying, "Water is life." Think about it for a minute. Can you think of any **organism** that does not depend on water?

David Quammen, in his book *Natural Acts, A Sidelong View of Science and Nature,* says, "Without life, there would still be water. Without water no life."

Recipe for a Lake

For your visit to Lake Norman State Park, you need to know more about water in the form of a lake. A lake is defined as a large inland body of fresh or salt water. To really understand a lake, you also have to know about its **watershed** – all the land that drains into the lake. A healthy lake must have a well-protected watershed because any disturbance to the land in the watershed affects the **water quality** in the lake.

Lake Norman is actually a manmade lake. It is the largest of a series of reservoirs located along the Catawba River. The watersheds of the Catawba River's many reservoirs and **tributaries** are interconnected. They form a giant watershed, known as a **river basin**. Lake Norman is affected by all the watersheds *upstream* in the Catawba River Basin. Likewise, Lake Norman affects all the watersheds *downstream* in this river basin.

Recipe for a Lake

A lake can be compared to a fine stew or soup. Just like a lake, a fine stew or soup needs a variety of healthy ingredients. A stew also needs small amounts of spices to make it taste just right. If you try to make a stew with just one ingredient, or if you leave out an important spice, your stew is not going to be good.

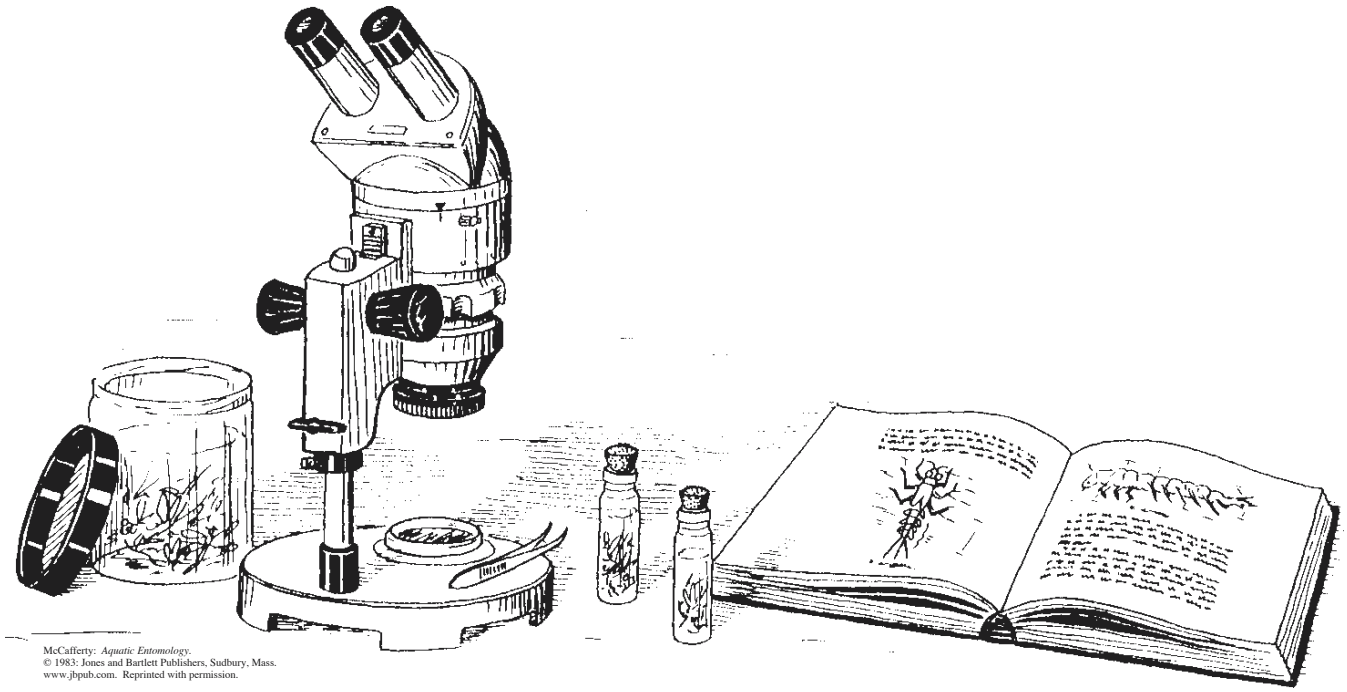
Here, then, is a recipe for a fine, healthy lake:

1. Sunlight – Algae, moss, diatoms and **aquatic** plants need some sunlight to **photosynthesize**. However, too much sun heats the water and robs it of **dissolved oxygen**.

2. Dissolved oxygen and carbon dioxide – All the animals in the lake need dissolved oxygen to breathe. These same animals breathe out carbon dioxide that is essential for algae and other aquatic plants. These plants, in turn, take in the carbon dioxide and give off oxygen.

3. Fallen leaves – Dead leaves provide the main source of energy for a river system and thus for a lake as well. In the fall, leaves drift down from the trees into the water where they soon sink to the bottom or get caught in logjams or wedged between rocks. **Decomposers**, such as bacteria and fungi, climb aboard the leaves and begin to "munch out." They cause the leaves to break down into smaller pieces. The half-eaten leaves, bacteria and fungi are eventually swept downstream where they provide food for the wonderfully adapted **macroinvertebrates** (macros), such as stonefly **nymphs**, mayfly nymphs and caddisfly **larvae**. These organisms further break down the leaves into a very fine mulch called **detritus**.

In addition to the munchers, grazers and filter



feeders, some macroinvertebrates prey on other macroinvertebrates. Lots of different kinds of macros are a sign of a healthy lake or river.

4. Aquatic plants and animals – Aquatic plants provide cover for macros and small fish. All the aquatic animals in the lake provide food for each other and for non-aquatic animals in a complex **food web**. When the various plants and animals die or excrete waste, they return essential nutrients that were borrowed so that they could live.

5. Various minerals – The fine spices of a lake include calcium bicarbonate, potassium, nitrates and phosphates. These ingredients help balance a lake's **pH**; provide building material for the shells of snails, **mussels**, clams and crayfish; help fish breathe more efficiently; and act as natural fertilizers essential for aquatic plants.

Is the Lake Healthy?

The five ingredients just listed are the minimum ingredients needed for a healthy lake. A lake needs only natural ingredients – unnatural ingredients can have a bad effect. David Quammen sums up what makes a healthy lake or river when he talks about a trout stream: "A good trout stream must first be an excellent **insect** stream, a superior haven for algae and fungi and bacteria, a prime dumping ground for dead leaves, a surpassing reservoir of oxygen and calcium. It will then also, and thereby, be a good osprey stream, a favorite among otters, a salvation to dippers and kingfishers and bank swallows and heron, mergansers and Canada geese and water shrews, mink and muskrat and beaver. Not to mention the occasional grizzly bear. And who knows but that, sometime, a human might want to drink."

By taking samples of the aquatic animals, you can monitor the lake's water quality. Before you sample, study the Picture Key to Aquatic Macroinvertebrates. The animals listed as " I," intolerant, are indicators of *good* water quality. They belong to Group I. The animals listed as "T," tolerant, are members of Group III. If you find only animals from Group III in your water sample, the lake is *polluted*. You can use the animals you collect to calculate an **aquatic index** value and aquatic index rating of a lake or stream. The aquatic index is a measure of the health of a water body. A healthy lake has a high aquatic index value and is home to a wide variety of different **species** of plants and animals.

Calculating the Aquatic Index Value

The aquatic index value (AIV) is a measure of the water quality of a lake, river or other body of water. In general, water bodies with the greatest number of *different kinds* of macroinvertebrates have the best water quality. Macroinvertebrates are divided into three categories or groups based on their tolerance to **pollution**:

Group I – includes macroinvertebrates that are very *intolerant* (I) to water pollution. If you find many species from Group I in a river or lake, this indicates good to excellent water quality. For the AIV calculation, species in Group I are given an index value of 3.

Group II – includes macroinvertebrates that are *moderately tolerant* (M) to a reduction in water quality. For the AIV calculation, species in Group II are given an index value of 2.

Group III – represents macroinvertebarates that are *tolerant* (T) to pollution. If you find mostly species from Group III in a river or lake, this indicates poor water quality. For the AIV calculation, species in Group III are given an index value of 1.

To calculate the aquatic index value, you will use a simple formula:

AIV = (3 x number of Group I) + (2 x number of Group II) + (1 x number of Group III)

As an example, let's say that you have sampled a lake and found the following species:

Group I	Group II	Group III
1. Hellgrammite	1. Dragonfly nymph	1. Black fly larva
2. Mayfly nymph	2. Crayfish	2. Freshwater worm
3. Stonefly nymph	3. Water scorpion	
4. Caddisfly larva		

AIV = (**3** x 4 species) + (**2** x 3 species) + (**1** x 2 species) = **19**

Find the AIV on the chart below to get the aquatic index rating:

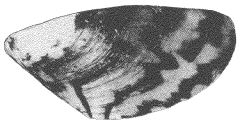
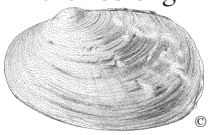
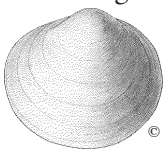
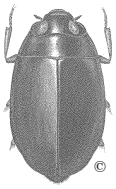
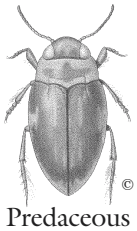
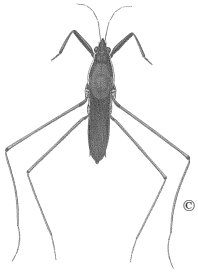
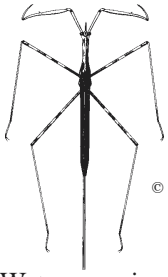
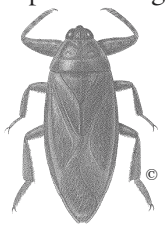
An AIV of 19 lies within the "Good" range. Your lake has good water quality, at least in the areas in which you collected samples.

Cumulative Index Values	**Aquatic Index Rating**
23 and above	Excellent
17 to 22	Good
11 to 16	Fair
10 to less	Poor

Adapted from *A Field Manual for Water Quality Monitoring*, *An Environmental Education Program for Schools* by Mark K. Mitchell and William B. Stapp.

Picture Key to Aquatic Macroinvertebrates

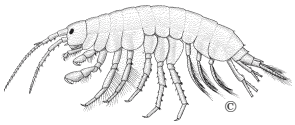
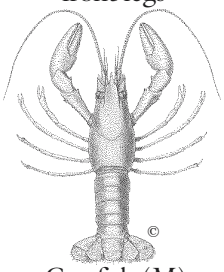
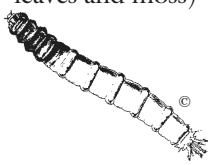
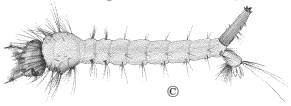
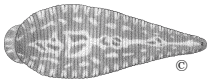
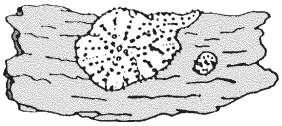
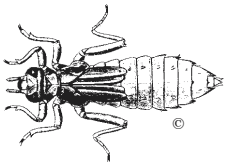
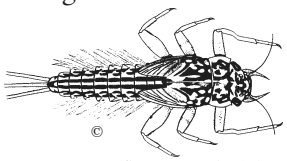
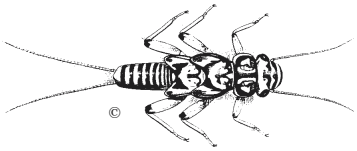
Macroinvertebrates

- with shells, clam-like
  - shell attached to submerged objects
    - 
    - *Zebra mussel (T)
  - shell unattached
    - shell oblong
      - 
      - Native freshwater mussel (I)
    - shell triangular
      - 
      - *Asian clam (T)
- obvious legs
  - three pairs of legs
    - adult bugs or beetles with two pairs of wings
      - chewing mouth parts, front wings thick (beetles)
        - hind legs short (swims on surface)
          - 
          - Whirligig beetle (M)
        - hind legs long
          - hind legs paddle-like (swims rapidly)
            - 
            - Predaceous diving beetle (M)
          - hind legs not paddle-like (crawls on submerged objects)
            - 
            - Riffle beetle (I)
      - sucking mouth parts (true bugs)
        - thin body, long spider-like legs
          - skates on water surface
            - 
            - Water strider (M)
          - walks on bottom near plants, long tube on abdomen
            - 
            - Water scorpion (M)
        - thick body, up to 3" long
          - 
          - Giant water bug (M)
    - larvae or nymphs with no wings, but some have undeveloped wing pads
      - abdomen soft and worm-like
        - dark brown to black body, prominent pinching jaws
          - 
          - Hellgrammite, Dobsonfly larva (I)
        - white to greenish body, with or without portable case
          - 
          - Caddisfly larva (I)
          - 
          - Caddisfly larva with case (I)

** Non-native nuisance species. The zebra mussel is not yet known in North Carolina. It is moving into the southern states. Report its occurrence to park, wildlife or Duke Energy authorities.*

Catawba River Watershed

LEGEND	
Pollution Tolerance	**Index Value**
(I) – Intolerant	**Group I**
(M) – Moderate	**Group II**
(T) – Tolerant	**Group III**

- without shells
  - no obvious legs
    - more than three pairs of legs (crustaceans)
      - small claws on front legs, may be hard to see
        - body flattened side to side
          - 
          - Amphipod, Scud (M)
        - body flattened top to bottom
          - 
          - Isopod, Sowbug (M)
      - large claws on front legs
        - 
        - Crayfish (M)
    - worm-like
      - small appendages and/or hairs
        - no obvious head (lives on submerged leaves and moss)
          - 
          - Cranefly larva (M)
        - obvious head
          - fat, rounded abdomen (lives in groups, attaches to rocks and sticks)
            - 
            - Black fly larva (T)
          - long, slender abdomen
            - bright red body (lives on submerged objects)
              - 
              - Chronomid midge (T)
            - small hairs on body (lives in stagnant water)
              - 
              - Mosquito larva (T)
      - no appendages
        - flattened, gray to black color
          - 
          - Leech (T)
        - cylindrical, red color
          - 
          - Aquatic worm (T)
    - sponge- or jelly-like, grows on submerged objects
      - usually a flattened pad
        - 
        - Freshwater sponge (M)
      - ball-like
        - 
        - Bryozoa (M)
  - entire body (exoskeleton) hardened and flattened
    - no obvious tail
      - 
      - Dragonfly nymph (M)
    - obvious tail
      - three tails
        - tails broad, leaf-like
          - 
          - Damselfly nymph (M)
        - tails slender, gills on abdomen
          - 
          - Mayfly nymph (I)
      - two tails, no gills on abdomen
        - 
        - Stonefly nymph (I)

Aquatic Sampling Worksheet

Name: _____ Date: _____

Location: _____

Methods used to sample: _____

A. Prediction of the park lake's aquatic index: Excellent Good Fair Poor
Circle your choice. Why do you think the park lake will have this aquatic index?

_____

_____

B. Instructions:

1. Use the Picture Key to Aquatic Macroinvertebrates to identify organisms.

2. Record the species found by your group in the space below. Use the key to classify them by their tolerance levels: I (intolerant), M (moderately tolerant) or T (tolerant).

Group I (I)	**Group II (M)**	**Group III (T)**
1.	1.	1.
2.	2.	2.
3.	3.	3.
4.	4.	4.
5.	5.	5.
6.	6.	6.
7.	7.	7.
8.	8.	8.
9.	9.	9.
10.	10.	10.
Total = _____	Total = _____	Total = _____

3. Calculate the aquatic index value (AIV) for the park lake by multiplying the number of species in each group by the index value for that group. Then, add the resulting three numbers to obtain the aquatic index value.

(3 x no. of species in Group I)
(2 x no. of species in Group II)
+ (1 x no. of species in Group III)
= Aquatic Index Value (AIV)

Cumulative Index Values	**Aquatic Index Rating**
23 and above	Excellent
17 to 22	Good
11 to 16	Fair
10 to less	Poor

Aquatic Index Value = _____ **Aquatic Index Rating = _____**

Adapted from *A Field Manual for Water Quality Monitoring, An Environmental Education Program for Schools* by Mark K. Mitchell and William B. Stapp.

4. What does the aquatic index tell you about the health of the park lake? What does this mean for plants, animals and people?

_____
_____
_____
_____
_____
_____

5. What do you think has contributed to the water quality? Hint: Remember the five ingredients for a healthy lake in the Student's Information.

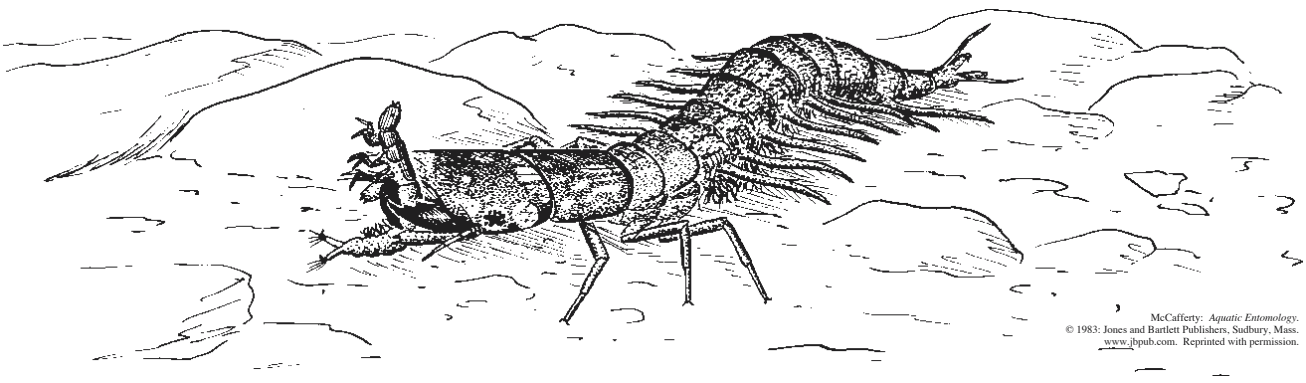
_____
_____
_____
_____
_____
_____

6. How do people affect the aquatic life in the park lake? Hint: Look around you for evidence of human activities.

_____
_____
_____
_____
_____
_____

7. What would happen if the aquatic food web in the park lake was damaged or disrupted?

_____
_____
_____
_____
_____
_____



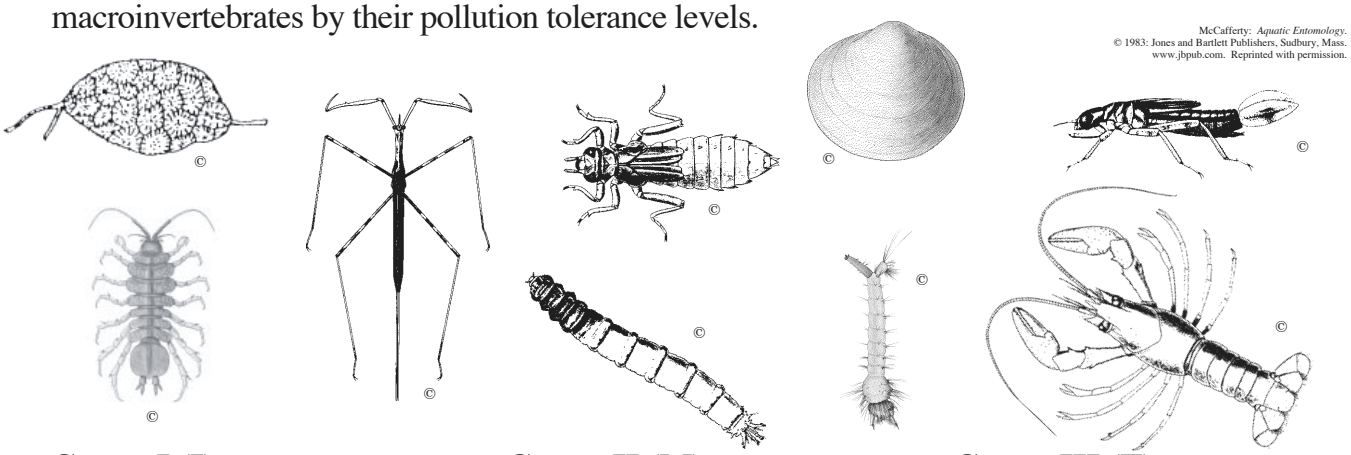
Life at the Bottom – Test

Name: _____ Date: _____

Instructions:

1. Use the Picture Key to Aquatic Macroinvertebrates to identify the macroinvertebrates below, which were found in Burns Lake.

2. Write the name of each species under the correct group. Use the key to help you classify the macroinvertebrates by their pollution tolerance levels.



Group I (I)	Group II (M)	Group III (T)
1. _____	1. _____	1. _____
2. _____	2. _____	2. _____
3. _____	3. _____	3. _____
4. _____	4. _____	4. _____
5. _____	5. _____	5. _____
6. _____	6. _____	6. _____
7. _____	7. _____	7. _____
Total = _____	Total = _____	Total = _____

3. Calculate the aquatic index value (AIV) for Burns Lake by multiplying the number of species in each group by the index value for that group. Then, add the resulting three numbers to obtain the aquatic index value.

(3 x no. of species in Group I)
(2 x no. of species in Group II)
+ (1 x no. of species in Group III)
= Aquatic Index Value (AIV)

Cumulative Index Values	Aquatic Index Rating
23 and above	Excellent
17 to 22	Good
11 to 16	Fair
10 to less	Poor

Aquatic Index Value = _____ **Aquatic Index Rating = _____**

4. On the back of this paper, describe the health (water quality) of Burns Lake, based on the macroinvertebrate sample above. Describe at least three ways that humans might be affecting the aquatic life in this lake.

Adapted from *A Field Manual for Water Quality Monitoring, An Environmental Education Program for Schools* by Mark K. Mitchell and William B. Stapp.

On-Site Activity #2 — Water Lab

Major Concepts:
- Water quality
- Temperature
- pH
- Turbidity

Learning Skills:
- Observing, communicating results, predicting, interpreting data
- Measuring
- Reading and interpreting scientific charts

Subject Areas:
- Science
- Mathematics
- English Language Arts

* See the Activity Summary for a correlation with the DPI objectives in these subject areas.

Location:
The old rental boat dock on park lake

Group Size:
Maximum of 25 divided into three groups, one adult per six students

Time: 1 hour

Appropriate Season:
Spring, summer or fall

Materials:
Provided by the park:
Per class: Life jackets, pH kits, vinegar, ammonia, two plastic cups, basters, large bucket, large clear plastic jar containing water sample from Lake Norman, large empty clear plastic bottle, thermometer, white paper, Secchi disk with string
Provided by educator:
Per student: One copy of Student's Information and Water Quality Information Sheet
Per team: One copy each of Water Lab Data Sheet, Water Quality Information Sheet, and Picture Key to Aquatic Macroinvertebrates (See On-Site Activity #1.)

Safety Considerations:
Because students will be on the beach when taking the pH reading, and on the boat dock when the temperature and turbidity readings are done, they will all be required to wear life jackets.

Credits: The Water Quality Information Sheet was adapted from "A Lesson Plan for Some Water Investigations," *Investigating Your Environment* series. U.S. Forest Service, revised 1977. Printed with permission.

Objectives:

- Name and describe three characteristics of water that contribute to the overall quality of a water sample or body of water.
- Determine the pH, temperature and turbidity of lake water samples and make inferences regarding the overall water quality based on the test results.
- Using the test results and other information, write predictions for the kinds of aquatic life that might live in the lake.

Educator's Information:

In this activity, students will conduct some simple physical and chemical tests to determine the quality of a body of **water**. Working in teams, students will determine the **pH**, turbidity and temperature of water samples from the park lake and record their findings on their data sheets. Using the data collected and the Water Quality Information Sheet, they will predict the types of **organisms** that the park lake can support and draw conclusions regarding the overall **water quality**.

To ensure the success of this activity, teachers should conduct one of the pre-visit activities in this EELE and practice the skills suggested in the Instructions for this activity. If time permits, students should do the On-Site Activity #1, "Life at the Bottom," as a follow-up. This will help students check the accuracy of their predictions about the types of **aquatic** life inhabiting park lake.

Instructions:

1. Before departing for the park, go over the Student's Information and Water Quality Information Sheet with the class. Explain the types of tests the students will be conducting at the park. Divide the class into teams of two to three students. Conduct a guided practice of skills they will be using at the park.

Suggestions for Skills to Practice:

If you have thermometers available, let the teams practice taking air temperature readings in the classroom and on the school grounds. If you have litmus paper, let the teams take pH readings of various materials such as tap water, soda, milk, vinegar, bleach, hand soap, etc. Although the students will be using a more sophisticated test for pH at the park, the litmus paper test will familiarize them with the pH ranges of common materials. You could also give each team one copy of the Water Lab Data Sheet and Water Quality Information Sheet. Then, explain how to make predictions using the Water Quality Information Sheet. For example, if a student team discovers that the pH of the lake water is 6.0, what types of organisms could live in the water? (Answer: bacteria, carp, suckers, catfish, some **insects**.)

If the water temperature is 69˚F, what kind of organisms could survive? (Answer: much plant life, many fish diseases, most bass, crappie, bluegill, carp, catfish, caddisfly, etc.)

2. Upon arrival at the park, the teacher should stop at the park office to get assistance in locating the equipment provided by the park. (See Materials.) Before beginning the water lab tests, the teacher should review the tests to be conducted and demonstrate the safe use of equipment such as the pH kits, thermometers and Secchi disks. Provide each team with a copy of the Water Lab Data Sheet, the Water Quality Information Sheet and the Picture **Key** to Aquatic **Macroinvertebrates** (from On-Site Activity #1).

3. Group the teams into three large groups, which will rotate through the three water quality testing stations: pH, turbidity and temperature. After the teams in each group complete a test, the groups should switch stations until all teams have completed all three tests. Remind the students that they should take turns within their teams to conduct the tests and record the data. Instructions and procedures for each test are given on pages 4.2.3 - 4.2.4.

4. When all the teams have done all the tests, gather the students together at the picnic shelter for a follow-up discussion. Ask individual teams to report their findings and predictions. Discuss the information in Predicting Aquatic Animals (Student's Information) again for emphasis.

Assessment:

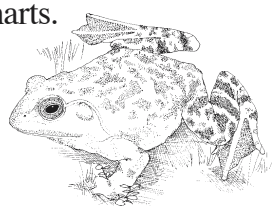
Create temperature, turbidity and pH readings for a fictitious lake. Give each student a copy of the Water Quality Information Sheet and the Picture Key to Aquatic Macroinvertebrates. Ask students to first explain how each individual factor (temperature, turbidity and pH) might affect aquatic life in general. Then, considering all three factors *together*, students should predict what kinds of organisms could live in the fictitious lake.

Suggested Extensions:

1. If you have extra time when visiting the park, do On-Site Activity #1, "Life at the Bottom." Did the students' observations of aquatic life match their predictions made during the "Water Lab" activity? If not, why not?

2. Find the range, median and mode for the class' data on pH, surface temperature and turbidity. Use a graph to show the change in temperature with depth.

3. Repeat the water lab tests at another lake or river to compare with the park lake. Display results using graphs, tables or charts.



Temperature Test

1. Lead the group to the boat dock area to conduct the temperature tests. One student in each team will be responsible for handling the thermometer, another for recording the data, and a third for timing the temperature tests. Demonstrate the procedure for taking temperature at various depths.

2. First, holding the thermometer in a shaded place, and have the students determine the temperature of the air. Caution them to avoid touching the thermometer bulb.

3. Next, to measure the temperature of the surface water, grasp the top end of the thermometer and place the bulb just under the surface of the water. Hold this position for two minutes. Take a reading.

4. Lower the bulb three feet (measured along the premarked string), wait two minutes, and take another temperature reading.

5. Lower the bulb to a depth of six feet, wait two minutes, and take another temperature reading.

6. Have the students record each temperature reading on their data sheet. Surface waters will be somewhat warmer (except in winter) than deeper water. Not only do surface waters absorb more sunlight, but warm water "floats" on colder water. Note: Water is the most dense at 39˚F (4˚C). Water cooler than 39˚F will float on top of this warmer water! This is why ice forms on the lake surface rather than the lake bottom.

7. Using the data collected and the information sheet (section on temperature ranges), have the students describe what types of life they think might be present.

pH Test

1. Lead the group to the beach area to conduct the pH test.

2. Demonstrate to the class the different extremes on the pH scale by using the pH kit to measure the pH of a cup of vinegar (very **acidic**) and a cup of ammonia (very alkaline). Demonstrate how to conduct a pH test on lake water samples, as described below.

3. Each group will receive a baster and pH kit.

4. Collect a sample of the park lake water in a large bucket. Have one member of each group use the baster to draw water from the bucket and place it into the tube in the pH kit, filling the tube to about a quarter inch from the top.

5. Have another team member place one drop of the indicator solution in the tube, place the lid on the tube, shake it and wait 10 seconds. Have all three students compare the color of the solution in the tube with the chart on the front of the pH kit and choose the number of the color it most closely resembles.

6. Have the third student record the pH reading on the team's data sheet.

7. Using the data sheet and information sheet (section on pH ranges), discuss the results. Have the students describe the health of the

water in terms of its pH level. What life forms might they expect this water to support? (Possible answers: bacteria, **algae**, bass, crappie, trout, mayfly, stonefly, bass, crappie, caddisfly, carp and catfish.) What life would this water *not* support? (Possible answers: snails, **mussels**, clams.) What factors may have contributed to this pH reading? (Possible answers: **acid rain** caused by nitrogen oxide from automobiles and sulfur dioxide from factories, agricultural **runoff** containing a surplus of nitrogen fertilizers, lime from residential runoff, and decaying vegetation in water.) How does the pH of the park lake compare with the pH level of Lake Norman? Note: Contact the park staff for this information. (Possible answer: Lake Norman is usually slightly less acidic than the park lake because Lake Norman has a huge volume of water that dilutes potential pollutants. Therefore, Lake Norman can handle more pollutants than a smaller lake before the overall water quality is affected.

Turbidity Test

1. Lead the group to the boat dock area (but away from temperature testers) for the turbidity test.

2. Collect a sample of the park lake water in a large plastic jar. Make sure it is free of any obvious debris.

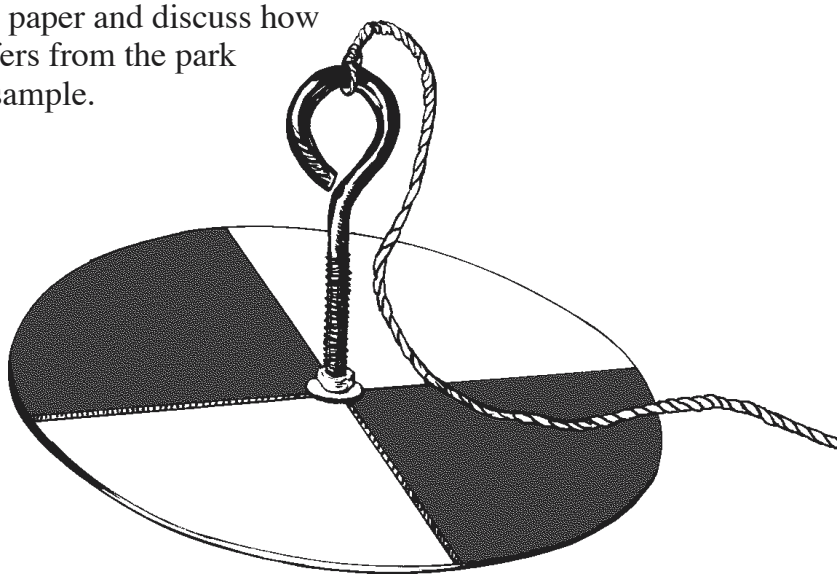
3. Have the students examine it against a background of white paper.

4. How would they describe the color? Is it colorless, greenish, murky tan, a clear tea or coffee color? Discuss the possible explanations for the color.

5. Present a glass jar that has a water sample taken from Lake Norman. Place it against a background of white paper and discuss how it differs from the park lake sample.

6. Have one member of each team lower a Secchi disk into the water slowly. The other team members should observe and record on the data sheet the depth at which the Secchi disk disappears. Note that the string has been marked to aid students in determining the depth in feet.

7. Discuss what effect the water's clarity (or lack of it) might have on the aquatic organisms living there. Use the Picture Key to Aquatic Macroinvertebrates to identify anmals that are intolerant to **pollution**. On the basis of this key, which organisms do you predict could live in park lake and which ones are most likely absent? Write your predictions on the data sheet.



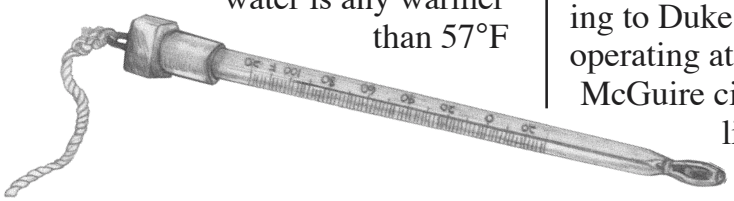
Student's Information

Water quality is a term used to describe the ability of a body of **water** to support life. Several characteristics of the water must fall within certain ranges if the water is to be considered "safe" for people to drink or for wildlife to use. Lake Norman, the park lake and other bodies of water can only absorb certain amounts of pollutants before the overall water quality goes down. Then, animals die and people get sick.

When you come to Lake Norman State Park, you will be measuring three characteristics of water: temperature, turbidity and **pH**. After making your measurements, you will have a better idea of the overall water quality of the park lake. You will also be able to predict the kinds of animals that could live there.

Temperature

Water temperature is a life or death factor for the many animals, plants and microorganisms living in water. Most trout, which thrive in cold water, will die if the water temperature gets as warm as 77°F (25°C). In addition, their eggs won't hatch if the water is any warmer than 57°F (14°C). Carp, on the other hand, are considered warm-water fish. They can easily withstand water temperatures as warm as 100°F (38°C).



Temperature also affects **dissolved oxygen**, the amount of oxygen dissolved in water. Fish and other **aquatic** animals need the oxygen that is dissolved in water. When the oxygen level falls below a certain point, they die. The rule is the warmer the water, the less oxygen it can hold. As water temperatures rise, dissolved oxygen escapes from the water into the air. Some animals need more dissolved oxygen than others. Therefore, water that is considered deadly and polluted for some fish, because of low dissolved oxygen levels, may be perfectly safe for other fish. (See the Water Quality Information Sheet for temperature ranges and dissolved oxygen requirements for aquatic **organisms**.)

Many factors such as weather, the seasons and manmade facilities affect water temperature. McGuire Nuclear Station and Marshall Steam Plant, both located on Lake Norman, use large amounts of lake water to cool their steam turbines, according to Duke Energy. When operating at full capacity, McGuire circulates two million gallons of lake water a minute. The lake water helps condense the steam produced to turn the turbines. The water used for cooling is eventually returned to the lake, slightly warmer than the rest of the lake water. According to Duke Energy, the water is not warm enough to hurt fish or other aquatic life.

The area where the McGuire Nuclear Station discharges warm water into Lake Norman is known as a "hot spot" and is very popular with fishermen, especially in winter. Shad flourish in the warm waters and many larger game fish go into these waters to feed on shad. Since the lake is large, the fish can migrate back and forth between warmer and cooler areas.

Another factor affecting water temperature is a natural process called **thermal stratification**. This process occurs to some degree in all bodies of water. The lighter, warmer water floats on top of the denser, cooler water. These two separate layers provide different **habitats** where different types of aquatic plants and animals live, mainly due to the differences in temperature.

This is why fish that need cooler water, such as trout and striped bass, swim to the deeper parts of lakes during warm summer days.

pH

pH is a measure of how **acidic** or **basic** something is. Scientists use a pH scale to define degrees of acidity. The scale is represented by numbers from 1 to 14. A pH of 1 is extremely acidic, while a pH of 14 is extremely basic, or alkaline. A pH of 7 is neutral, neither acidic or basic. Pure water has a pH of 7. Some examples of the pH of common liquids around you include:

Vinegar	pH of 2.25
Cola	pH of 4
Rain	pH of 5.6
Milk	pH of 6.5
Sea Water	pH of 7.5

pH Scale

1 -------- 7 ------ 14

acidic neutral basic

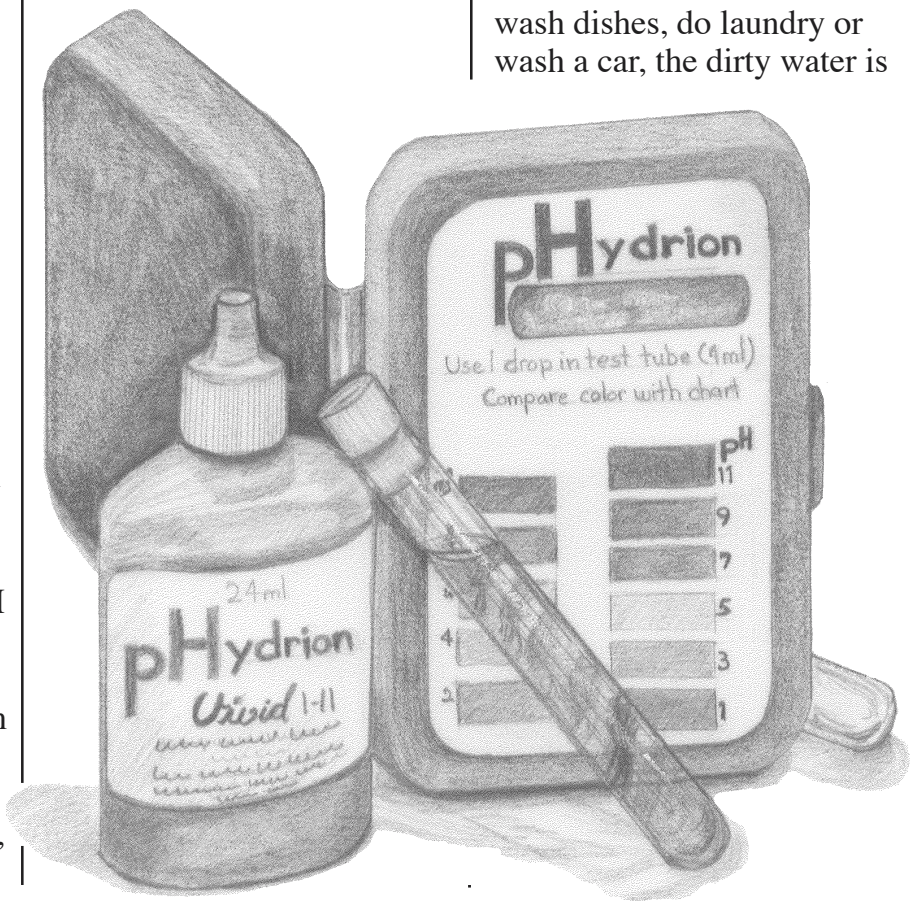
If you look at the Water Quality Information Sheet, you will see how pH affects plants and animals. Bacteria can live at almost any pH level, from 1 to 13. Most plants and animals, however, can't survive for very long in water that is below pH 6.0 or above pH 9.0.

Many factors affect the pH levels in a lake. Every day millions of cars emit a gaseous pollutant called nitrogen oxide. Nitrogen oxide mixes with water vapor in the air to create **acid rain**. In addition, thousands of factories and electric power plants release other gases such as sulfur dioxide into the air. These gases create more acid rain. The acid that falls to Earth lowers the pH level of lakes, rivers and streams. In some places in the world, the water is so acidic that it is called "dead." The water may look clean and pure, but nothing can live in it and no one can drink it.

Marshall Steam Station is a large power plant on Lake Norman. In burning coal to generate electricity, this plant emits sulfur dioxide into the air. This plant is one of the many sources of acid rain in our area. It is difficult to determine how much this power plant is actually affecting the pH of Lake Norman.

In addition to acid rain, **runoff** affects the pH level of the lake. When it rains, extra fertilizers from farm fields run into the lake. Most fertilizers contain nitrogen, which lowers the pH of the water. Runoff from people's yards can add more nitrogen to the lake. Some homeowners use lime, which is very basic, to make their grass greener and healthier. If lime washes into the lake, it may cause pH levels to go up.

Wastewater treatment plants also have an impact on pH levels in the water. There are a number of wastewater treatment plants in your home town and on Lake Norman. Whenever we use the bathroom, take a shower, wash dishes, do laundry or wash a car, the dirty water is



piped to a wastewater treatment plant. Here it is cleaned and released back into the lake. Many of the household cleaners we consistently flush down the drain are basic, but some are very acidic. Occasionally, treatment plants are overloaded and are unable to bring the pH to a more neutral level.

Turbidity

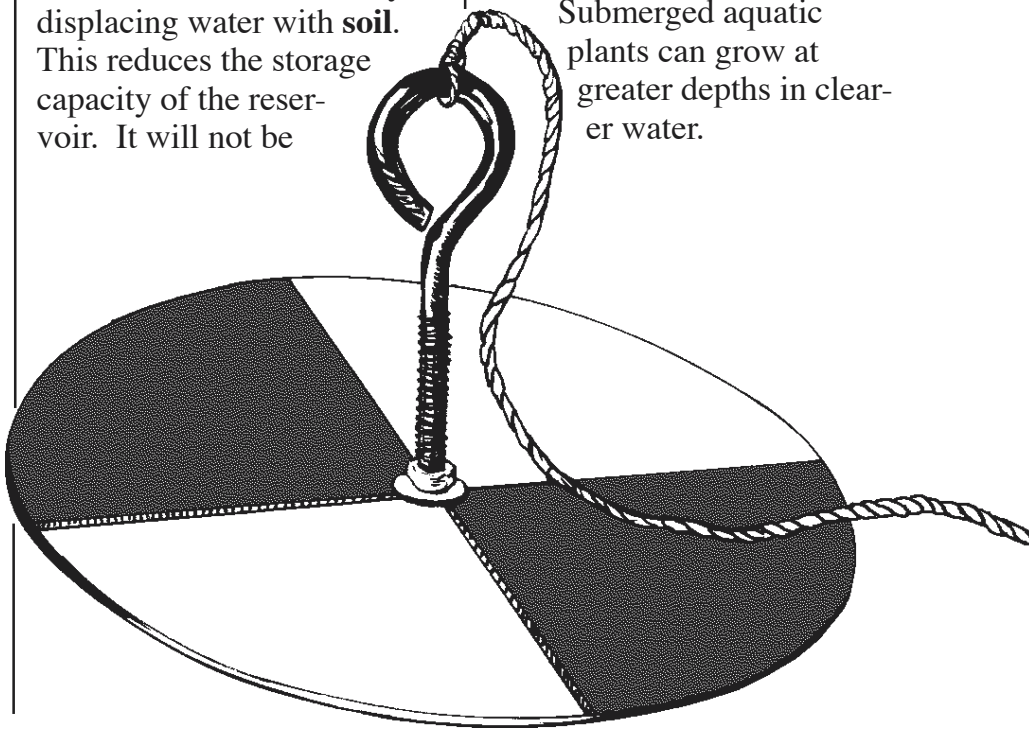
Turbidity refers to the amount of **sediment** or foreign particles suspended in water. Turbidity is another indicator of water quality. Very muddy, dark or dense water is called turbid. Turbidity is determined by a number of factors, both natural and manmade.

Very green-colored water may be overpopulated with **algae**. This could be the result of extra fertilizers from agricultural runoff. A tan, murky color may be the result of a heavy load of **silt**. Silt is a very fine-grained sediment that doesn't easily settle out of running water. Silt particles will settle out if the water sits undisturbed for a few days. A body of water that is a reddish color is full of suspended clay that has not yet settled to the bottom of the water. A weak tea or coffee color in otherwise clear water indicates decomposing leaves and bark. Tannin or tannic acid from decaying leaves is a major contributor to the turbidity of water. This same color may also be an indicator of chemical **pollution**.

The **macroinvertebrates** listed as intolerant to pollution (I) on the Picture Key to Aquatic Macroinvertebrates are especially sensitive to sediment pollution. Too much sediment sitting on the bottom of a lake can destroy the habitat for many bottom-dwelling animals. Sediments also directly smother these animals or their eggs and **larvae**. When smaller animals are killed, the larger animals that depend on them for food will have to find food elsewhere or die. In this way, sediments can destroy the **food chains** or **food web** of an entire lake. People who depend on fish, or other aquatic animals, for their livelihood are also affected.

Sediments can cause reservoir volumes to decline by displacing water with **soil**. This reduces the storage capacity of the reservoir. It will not be able to hold as much drinking water or absorb as much floodwater. Large silt deposits at the mouths of rivers, or in lakes, can cause navigation problems for boats. Dredging to remove sediments is costly. Overall, sediment pollution is the hardest type to prevent or clean up!

A Secchi disk is one device that is used to measure turbidity. The disk is lowered into the water until it disappears from view. The depth of the disk can be read from the marked rope. For still water, a Secchi disk reading of five feet or less indicates the water is very murky. A large number of particles are probably suspended in the water. A reading of 20 feet would indicate fairly clear water with few suspended materials. Clearer water allows sunlight to penetrate deeper into the water. Submerged aquatic plants can grow at greater depths in clearer water.



Predicting Aquatic Animals

After you determine the temperature, pH and turbidity of the water in park lake, you will use the Water Quality Information Sheet and the Picture Key to Aquatic Macroinvertebrates to predict the kinds of animals that might live there. As you make your predictions, remember:

The animals in a river or lake reflect the *worst* possible conditions in that body of water. For example, if the water is clear and cold, but the pH is below 6.5, you would *not* expect to see trout, stoneflies or mayflies. You also need to consider the impact of isolated pollution events. For example, if the water temperature is extremely high for one week of the year, it could kill some animals that might normally live there. When you visit the park lake, the temperature readings that you take may not be very high. And, based on your readings, you may predict that many kinds of animals should be able to live in the lake. But, water quality can change from day to day. One significant pollution event could destroy animals and their habitats. It could take a long time for the animals to return.

It is also important to remember that Lake Norman is a manmade lake. Most of the aquatic animals that live in Lake Norman or the park lake once lived in a river or stream environment. Only the animals that were able to survive when the river was converted into a lake are found in Lake Norman today. Scientists call these animals "tolerant" because they are able to survive fairly large changes in temperature, pH and turbidity. They can exist in a wide variety of water quality conditions. Animals that are less tolerant of change were probably eliminated when the river was converted to a lake.

Macroinvertebrates Listed on the Water Quality Information Sheet

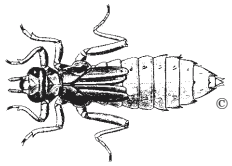
T = Tolerant of Pollution; M = Moderately Tolerant; I = Intolerant of Pollution


Black fly larva (T)


Caddisfly larva (I)

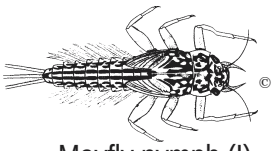

Damselfly nymph (M)


Diving beetle (M)

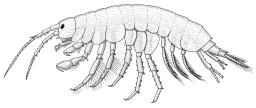

Dragonfly nymph (M)

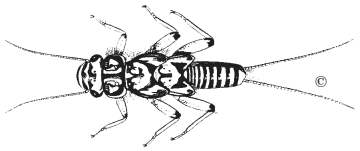

Freshwater mussel (I)

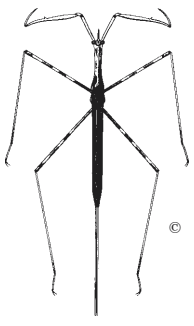

Hellgrammite (I)

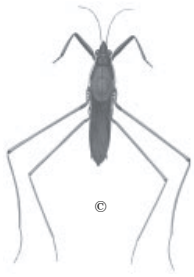

Mayfly nymph (I)


Riffle beetle (I)


Scud (M)

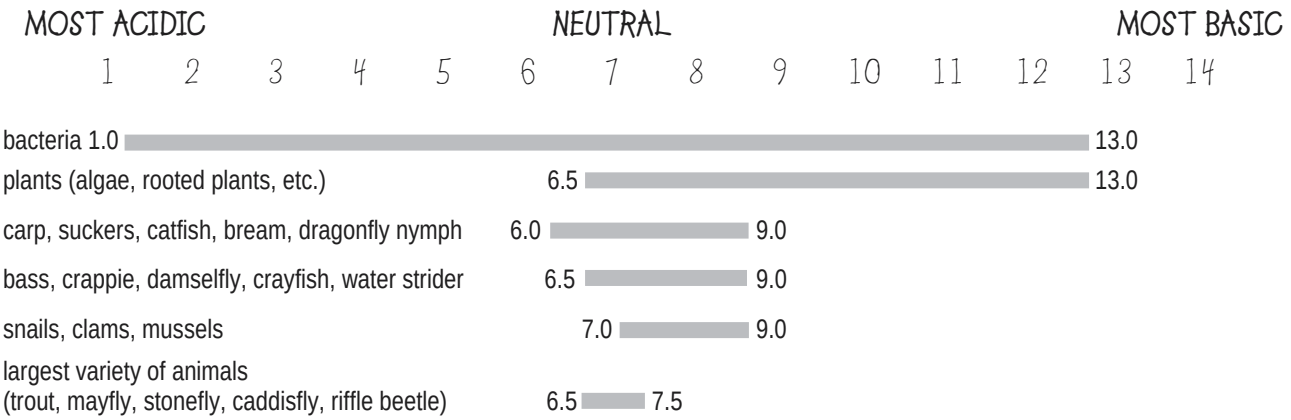

Stonefly nymph (I)


Water scorpion (M)


Water strider (M)

Water Quality Information Sheet

pH Ranges That Support Aquatic Life



Temperature Ranges (Approximate) Required for Certain Organisms

Greater than 68°F (20°C) warm water	much plant life, many fish diseases most bass, crappie, bluegill, carp, catfish, caddisfly, dragonfly, damselfly, water scorpion, diving beetles, crayfish, scud, water strider
Middle range: 55°F – 68°F (12.8°C – 20°C)	some plant life, some fish diseases salmon, trout, stonefly, mayfly, caddisfly, water beetles, black fly larva
Low range: Less than 55°F (12.8°C) cold	trout, caddisfly, stonefly, mayfly, hellgrammite, freshwater mussel

Dissolved Oxygen Requirements for Native Fish and Other Aquatic Life

Dissolved Oxygen in parts per million (ppm)

(below 68°F)	(above 68°F)
Cold-water organisms (including salmon and caddisfly, stonefly, mayfly, hellgrammite)	Warm-water organisms (including fish such as bass, crappie, catfish and carp)

6 ppm — 5 ppm

From "A Lesson Plan for Some Water Investigations." *Investigating Your Environment* series. U.S. Forest Service. Revised l977. Printed with permission.

Water Lab Data Sheet

Date: _____

Team members' names: _____

_____

pH of Park Lake Sample: _____

Predictions of aquatic life: _____

_____

_____

Temperature Readings:

Air temperature _____ Surface water temperature _____

Temperature at different depths:

3 ft. _____ 6 ft. _____

Predictions of aquatic life: _____

_____

_____

Turbidity:

Depth where Secchi disk disappears: _____

Predictions of aquatic life: _____

_____

_____

Describe the overall water quality of the park lake and the kinds of organisms you might expect to find there. _____

_____

_____

_____

On-Site Activity #3 — Lake Watchers

Major Concepts:
- Water quality
- Dams
- Runoff
- Sedimentation
- Turbidity
- Urbanization
- Recreation
- Water pollution
- Aquatic life

Learning Skills:
- Observing, communicating, inferring
- Collecting, analyzing and evaluating information
- Map reading and taking responsible action

Subject Areas:
- Science
- English Language Arts
- Social Studies

* See Activity Summary for a correlation with DPI objectives in these subject areas.

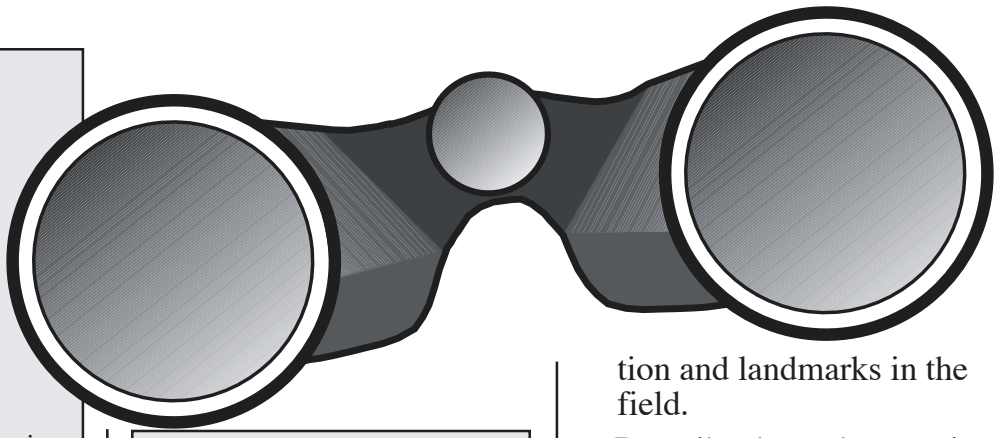
Location: Alder Trail

Group Size: 30 or less, preferably in groups of 10 or less with a minimum of one adult leader per group

Time: 1 - 1 1/2 hours

Appropriate Season:
Any – spring and fall recommended

Special Considerations:
- Leaders should scout trail before the walk to become familiar with recommended stops and to recognize potential hazards (i.e. slippery rocks, cliffs, poison ivy, etc.)
- Leaders should carry a first aid kit, water, a whistle and a throw rope.



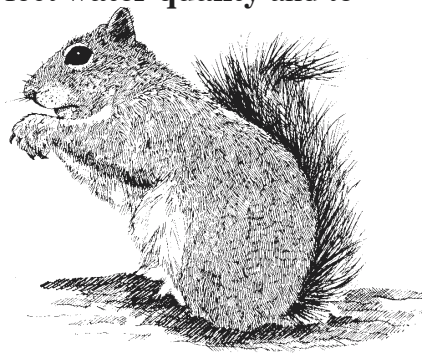
Materials:
Provided by park:
Per adult leader: One leader's kit containing a throw rope, whistle, topographic map, *Pond Life* guide and several laminated Lake Watchers Investigation Charts
Per each pair of students: One litter bag
Provided by the school:
Per class: One first aid kit and water bottle
Per adult leader: One copy of the Lake Watchers Teacher's Guide, Common Alder Trail Aquatic Plants and Wildlife, Lake Watchers Investigation Chart and Lake Watchers Trail Map

Objectives:

- Describe three positive effects and three negative effects of dams on people and wildlife.
- Describe two ways that people can minimize the negative environmental impacts of dams.
- Identify three examples of aquatic plants and animals found in the field.
- Use a topographic map to identify direction, elevation and landmarks in the field.
- Describe three characteristics of water that people can observe in order to make inferences about water quality.
- Explain how urbanization affects water quality.
- List two negative impacts of recreation on water quality.

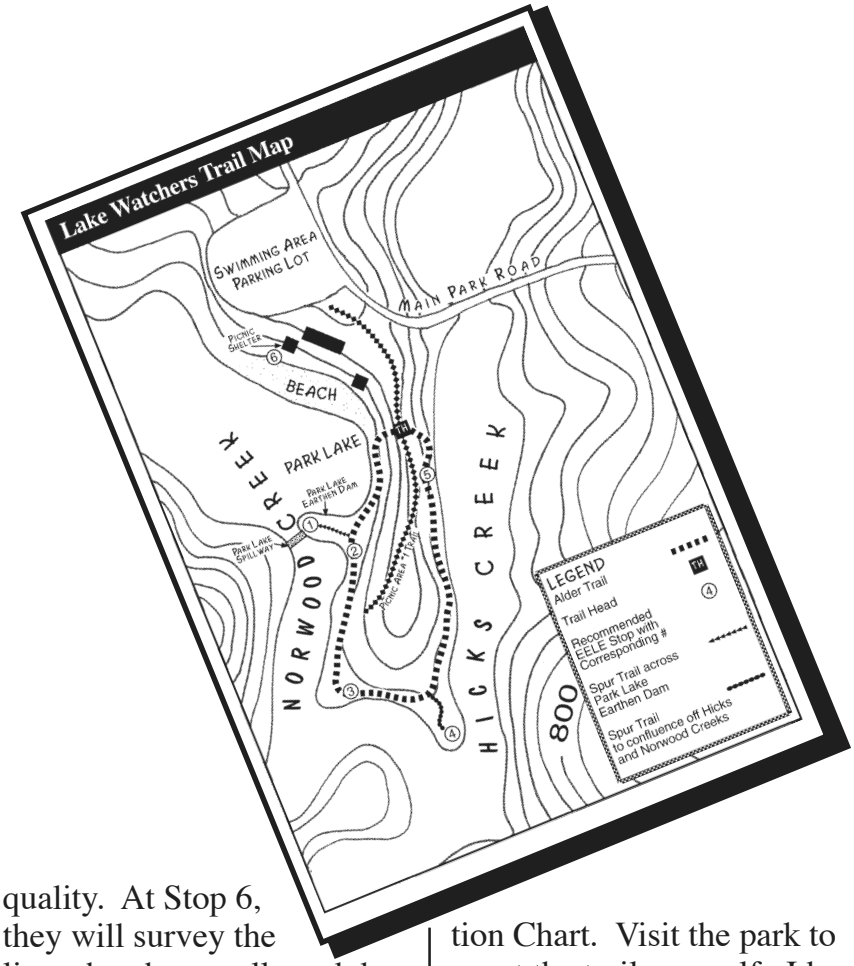
Educator's Information:

This activity is an easy hike that takes place on the Alder Trail, a three-quarter-mile loop trail. The trail follows the shoreline of a large peninsula located between the Hicks and Norwood creek sections of Lake Norman. The purpose of this activity is to provide students with a firsthand look at some of the factors that affect **water quality** and to



allow students the opportunity to study the effects of such factors. Educators will guide students along the trail and stop at six different locations for observation and discussion. Depending upon the season, students will have opportunities to observe and identify examples of **aquatic** flora and fauna, including turtles, waterfowl and various plants. Take advantage of unexpected wildlife sightings and stop to enjoy them.

At Stop 1, the students will examine the park lake dam, discuss the reasons dams are constructed, and identify the benefits and drawbacks of dam construction. At Stop 2, they will look closely at the water, examining the color, turbidity, presence or absence of aquatic plants and animals, odor, and presence or absence of suds or films. They will be encouraged to use their observational skills to study and monitor bodies of water in their home communities. At Stop 3, students will examine red clay and learn how extensive farming practices have depleted the **soil** of valuable nutrients. At Stop 4, they will see and locate on a topographic map the actual area they studied during the Pre-Visit Activity #3, "River Roots." They will also discuss the effects of urbanization on water quality. At Stop 5, students will examine shoreline **erosion** and the effects of recreation on water quality. At Stop 6, they will survey the litter they have collected during the hike and learn how this litter affects wildlife and people. At this final stop, the students will also review and discuss what they learned during the hike. This hands-on interaction with the aquatic **ecosystem** will help students appreciate the natural resource and encourage them to become better stewards of the environment.



Instructions:

1. To ensure the success of this on-site activity, we recommend you conduct Pre-Visit Activity #3, "River Roots," in this EELE.

2. Before bringing students to the park, study the Lake Watchers Teacher's Guide and Lake Watchers Investigation Chart. Visit the park to scout the trail yourself. Ideally, this should be done at least one week prior to your class' visit and at the same time of day. This will help you identify potential trail hazards (slippery areas, steep banks, etc.) and become familiar with the exact locations of the stops described in the Lake Watchers Teacher's Guide. You could also look for additional stops to view plants and wildlife.

If you are unfamiliar with aquatic environments, you will need to carry a field guide or request assistance from park staff. An excellent all-purpose guide is *Pond Life* by the Golden Press. (See References section.) A list of commonly-observed wildlife is also included in

this activity. Two important points to recognize when observing **organisms** are: (1) It's *not* always important to identify the specific name of a plant or animal as long as the students appreciate it and understand its place in the ecosystem; (2) It *is* important to help your students relate the plants and animals to water quality – their dependence or influence upon it.

3. Divide the class into smaller groups of 10 students or less. Provide one adult leader per small group. Prior to the hike, give each leader a copy of the Lake Watchers Teacher's Guide, Common Alder Trail Aquatic Plants and Wildlife, Lake Watchers Investigation Chart and Lake Watchers Trail Map.

Note: You may choose to assign each trail stop to a team of two students within each hiking group. If so, each team will need a copy of the information in the Lake Watchers Teacher's Guide for their assigned stop so that they can prepare to lead the corresponding activity.

4. During the hike, one of the group leaders should carry the first aid kit and water bottle. All the leaders should carry a throw rope, whistle, topographic map, *Pond Life* and several Lake Watchers Investigation Charts. Each student should have a "buddy" in his/her group. Each pair of students will be given a small litter bag at the park to help with trail cleanup.

5. Begin the hike with a brief introduction during which you will cover the theme, trail distance, time, difficulty and the special rules, a - f, below.

a. Stay on the trail until told otherwise.

b. Watch for roots, stumps, sloped walking areas and other hazards. Running is not allowed on the trail.

c. Do not pick, injure or destroy any plants or animals in the park. (The purpose of the state parks system is to preserve and protect our natural resources.)

d. Being quiet will help you see more wildlife.

e. The adult leader should be at the *front* of the group.

f. When picking up litter along the trail, do not touch broken glass, twisted metal or fishing line with hooks.

6. When conducting the hike, start each small group at a different stop along Alder Trail so that the groups do not get too close to one another. Make sure all the leaders know the amount of time they have to spend at each of the five stops on Alder Trail. All groups should end their hikes at Stop 6, the picnic shelter. Remind the leaders that when pausing for discussion or to view an interesting object along the trail they should lead their group halfway beyond the object so that all students will have a good view. Three loud blasts on the whistle always indicate an emergency. Be sure to review emergency procedures with all the leaders before the hike.

Assessment:

Use the Discussion Questions at the end of the Lake Watchers Teacher's Guide on pages 4.3.8 and 4.3.9.

Suggested Extensions:

1. Lead a walk in a different aquatic environment. Ask students to record their observations and write conclusions about the water quality based on their observations. In groups, have them develop plans to improve the water quality and present these plans to the class.

2. Have students participate in the activity "To Dam or Not to Dam" found in the *Project WILD Aquatic Education Guide*. Students role play individuals representing differing perspectives and concerns related to the construction of a dam on a river. In "Something's Fishy Here," another activity from the same guide, students identify potential cause and effect relationships involving aquatic-related **pollution**, generate and evaluate alternative solutions to problems of aquatic pollution, and outline an action plan to reduce the negative consequences of aquatic pollution in their communities. See References section under Council for Environmental Education.

STOP 1: Park Lake Dam – What's It Good For?

Ask these questions to encourage the students to observe and make inferences:

1. What are the major features of the park lake dam?

Concrete apron, spillway, wooden gates, large earthen barrier

Background Information:

The dam itself consists of more than just the small area of concrete and wood you see in front of you. It actually starts back where we took the sharp right off of the Alder Trail. Tons of dirt and stone were brought in to create an earthen barrier to hold the water inside the park lake. Once the dam was built, Norwood Creek began to back up and expand far beyond the sides of the original creek bed.

2. Why do you think this dam was built?

It was constructed across Norwood Creek to create a safe swimming area where motorboats are not permitted.

3. Look closely at the concrete once again. Why do you think it was built to allow a small amount of water to flow over it?

This feature is called a spillway. It allows the park lake to remain at a constant level throughout the year, unless there is an exceptionally heavy period of rain or lengthy drought. The lake is much safer for swimming when it is maintained at a constant water level.

4. What is the purpose of the two wooden gates on each side of the spillway?

The gates allow more water to be released at one time.

Background Information:

Sometimes rangers may need to open the gates to let water flow out of the lake at a faster rate than usual. For example, it may rain so much that the spillway alone can't release enough water to prevent flooding.

5. What are some possible negative impacts of dams?

Dams alter the flow of a river and therefore change the **habitat** for aquatic life. Animals that require cold, fast-moving water will not survive. Dams also trap **sediment**, which can smother bottom-dwelling animals.

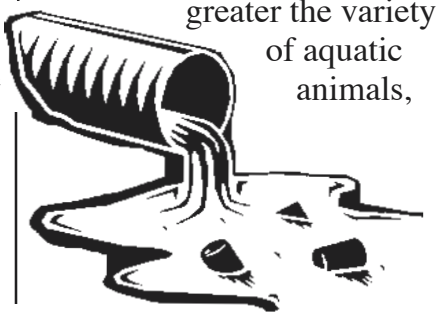
STOP 2: Small Cove Beyond Dam – Be a Lake Watcher!

Script – "We are now on the Lake Norman side of the dam. This creek, Norwood Creek, is a part of Lake Norman. Did you know that, without any expensive equipment, you can begin to determine the quality of water? That's right – all you need is your ability to make good observations with your eyes and your nose. If the water looks or smells unusual, there is probably something wrong with the water quality. Let's use the Lake Watcher's Investigation Chart to help us make inferences about the water quality of Norwood Creek."

Pass out the Lake Watchers Investigation Chart and challenge students to make careful observations. Warn the students that if they smell any strong odors or see anything unusual in the water they should not touch the water. Let them work with their "buddies" to make inferences from their observations about the water quality in the creek.

In addition to the observations included in the chart, students should look for the presence or absence of aquatic plants. If no aquatic plants are present, this could indicate that the water is too turbid to allow sunlight to penetrate.

The presence or absence of aquatic animals is also an important indicator of water quality. In general, the greater the variety of aquatic animals,



the better the water quality. There are also certain **macroinvertebrates**, such as **mussels** and mayflies, that are **indicator species** for good water quality. Of course, if students find dead fish or other dead animals, this could indicate very serious water quality problems.

When students have completed their investigation, ask them if they think the water in the creek is becoming polluted. What could be done about it? Please report your findings to the park.

Script – "Making sure that our water remains safe for wildlife and people is a very important task, and one in which you can be involved. Be a lake watcher! Take time to investigate streams, ponds and lakes in your communities as we have done here today. If you see something suspicious, notify the police department or the North Carolina Department of Environment and Natural Resources. You can help protect your drinking water!"

STOP 3: Exposed Red Clay Area – "Bygone Days"

Script – "Look at all the red clay that is present here. Feel how slick and firm it is. What does it smell like? Why do you think we see so much red clay here and so little vegetation? Long before there was a Lake Norman,

before the dam was built, the land beneath the lake was farmed extensively. Cotton and corn were major crops in the area. The fertile lowlands near the river were filled with valuable nutrients and moisture, and were ideal for farming. But after decades of farming, the nutrients in the **soil** were mostly used up, leaving behind the red clay we see here. This red clay forms much of the lake bed in Lake Norman and lacks the nutrients needed for growth by aquatic vegetation.

"The fact that young Virginia pines dominate this area instead of a mature hardwood forest indicates that not too long ago this area was farmland. In the process of **succession**, Virginia pines are one of the first trees to inhabit an area that was once an old field. Let's learn how to identify this tree. The Virginia pine has short (1 1/2 - 3 inches), twisted needles in bundles of two."

Guided Imagery Exercise (as time permits) –

Ask students to sit down on the ground and close their eyes. Tell students that you are going to describe what life in this area may have been like more than 100 years ago. The students should try to imagine what you are describing.

Script – "We are going to travel back in time to the early 1800s. There is no park lake; in fact, there is no park!

There aren't many trees because the forests have been cleared for farming. You live in an old farmhouse that your grandfather built in 1750 near the Powder Spring Branch of Norwood Creek. You get your water from a spring, and your mother does the family laundry in the creek.

"You share the farmhouse with six brothers and sisters. You sleep on a mattress made of straw, and your bathroom is an outhouse! A family cow provides milk and the flock of chickens in the hen house provides eggs. You eat a lot of cornmeal muffins because corn is a major crop on your farm.

"Every day you help your parents farm the fields near the river. You have to work very hard to raise enough cotton and corn to help feed the family. John Cavin, a neighbor, has recently established a grist mill on Hicks Creek. You really enjoy hooking up the horse and wagon and travelling to the mill with your father. It is a welcome relief from all the hard work in the fields.

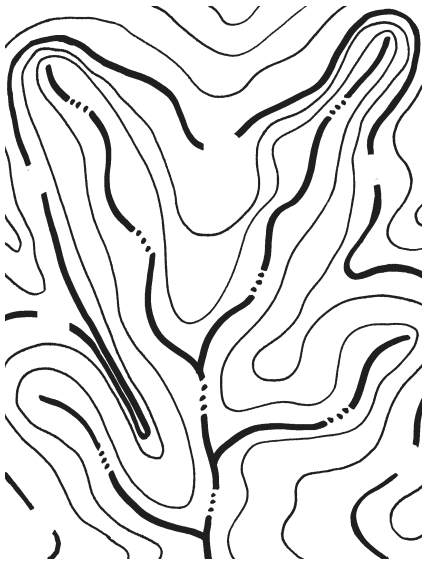
"You don't have any television or video games, so you find your fun in other ways. Your favorite place to play is the Catawba River. You like swimming there, but your mother won't let you swim alone. The current is so swift that it would be easy to drown. You like to fish, and sometimes you race toy boats made of sticks with your brothers and sisters. You really enjoy boating downstream to your uncle's farm. Of course, you don't have a motorboat, and you have to row hard to get back upstream again. Still, you like being in the boat, and one day you want to see the ocean.

"The world was very different back then. As you grew up, you realized that the fields were producing less and less because the topsoil was washing away. You knew you would have to make your living elsewhere, maybe in the big city of Charlotte!

"Let's come back slowly to the present now. Open your eyes. What if you had really lived back in the 1800s and were still alive today? What changes would you see if you came back to your old homestead? What changes do you think are good? What changes are not so good?"

STOP 4: Confluence of Hicks and Norwood Creeks – Map Exercise

If the teacher did not use "River Roots" as a pre-visit activity, the leader may have to explain to the students how to read a topographic map. First, see if the students can point out due North (without looking at the map), and then use the map to see how close they came. How could this map help if you were lost?



Next, the leader should point out major features of the topographic map such as contour lines, symbols for dwellings and numbers indicating elevations. Note that there is a 10-foot change in elevation between each contour line. Challenge the students to match landmarks or features that they can see around them with those on the topographic map.

Possible Questions:

- Can you find our location on the map? What is the approximate elevation? (Answer: 760 feet.)
- How far is it by boat from our location to Lake Norman (Answer: About two to three miles.)
- What would happen if you got into a boat here and travelled to the left? (Answer: You would eventually go under a bridge.)
- Looking at the map, is there much development along Hicks Creek? Why or why not? (Answer: No, the area on the right side of

Hicks Creek is state park land.)

- Find the Rocky Creek area on the map. Is it a developed area? (Answer: Yes, there are many black squares indicating structures.)
- Looking at the map and also looking around you, what activities can you find that may damage the water quality of Lake Norman?

Background Information:

Currently Lake Norman has more than 60,000 permanent residents living along its 520 miles of shoreline. Thousands more individuals live within the lake's **watershed**. (A watershed is all the land area that contributes **runoff** to a particular body of water.) Cities, towns, industries, farms and other businesses are also located within the watershed. Together, all of these people and places can significantly impact Lake Norman's water quality. As the watershed becomes more urbanized, the potential damage to the water quality is greater.

A big concern is polluted runoff. As rain washes across lawns, fields, parking lots, etc., it picks up fertilizers, soils, animal waste, toxic chemicals, petroleum products and other detrimental substances. This polluted runoff enters Lake Norman where it can damage the water quality. Some pollutants carried in runoff kill plants and macroinvertebrates that are essential to the lake's **food web**. Even in a lake as large as this one, pollutants can build up over time. Maintaining wetlands, forests and other vegetative buffers around the lake and its **tributaries** will help filter some of this polluted runoff.

STOP 5: Hicks Creek Side of the Peninsula – Recreation Impacts

Script – "Look and listen. Do you see any fishermen or hear any boat traffic? In addition to the thousands of permanent residents on Lake Norman, there are many other visitors, especially on weekends and holidays. Fishing, boating and water skiing are some of the most popular recreational activities on Lake Norman. Unfortunately, recreation is not all fun and games. See if you can observe any harmful effects caused by recreational activities."

Allow students to look around. Caution them to stay on the trail, away from the edge of the steep bank. After two or three minutes, ask students what they have found. Here are some possible answers:

1. Litter – This is the most obvious type of pollution that may be the result of recreational activities. Litter kills birds and fish when they become entangled in fishing line or six-pack rings. Some animals such as turtles may mistake styrofoam products for food and ingest the litter, thereby clogging their digestive systems.

2. Petroleum products – Students may be able to see a multicolored sheen on the water, or they may infer this from their observations of boats on the lake. Failure to maintain boats properly, spillage of gas while refueling and thoughtless disposal of oil all contribute to petroleum pollution.

3. Shoreline erosion – This is a significant problem facing unprotected shores of Lake Norman. Motor boats force powerful waves onto the shore, eroding the banks.

As the banks cave in, the soil breaks up and sediment enters the water. Some fishermen worsen the problem by cutting down trees along the shoreline to establish shelter for game fish. The tree roots that hold the soil in place can no longer do their job.

STOP 6: (Last Stop) Picnic Shelter – Litter Survey

Script – "Okay, now it's time for our litter survey. What are some of the different types of trash you collected on the hike? On a scale of 1 to 10, 10 being the most hazardous, how would you rate these items in terms of how potentially hazardous they are to wildlife and people? Why?"

Background Information:

• Styrofoam is often mistaken as food by fish and turtles. It takes 500 years to break down.

• A fish hook and fishing line can also hook and entangle birds. The hook can get caught in a bird's bill or wings, causing the bird to become so tangled in the line it can't fly. Or the bird may cut off one of its legs if it pulls too hard trying to escape. Fishing hooks can also be treacherous for barefoot swimmers.

• Six-pack rings are deadly necklaces. Diving birds like ducks and geese cannot see the rings and will noose themselves, carrying the rings with them until the birds are strangled. The rings will also cut into an animal's skin as it grows, causing great harm.

• Aluminum cans and plastic bottles are traps for small animals that get their heads stuck inside them. The animals die of starvation.

• Cigarette butts thrown in the water or on the ground are often eaten by wildlife. Fish and deer often mistake them for food and develop internal problems from eating them.

Script, continued – "Let's throw all of the trash in the cans under the picnic shelter and leave our extra, empty bags there, too, where the rangers can pick them up.

"In addition to what we just learned about litter, what else have we discovered on our hike today?

• "We learned the reasons dams are constructed, their benefits and drawbacks, and how dams affect water quality.

• "We learned that expensive equipment is not necessary to investigate a body of water; our senses of sight and smell work great. And, we should get involved and become Lake Watchers.

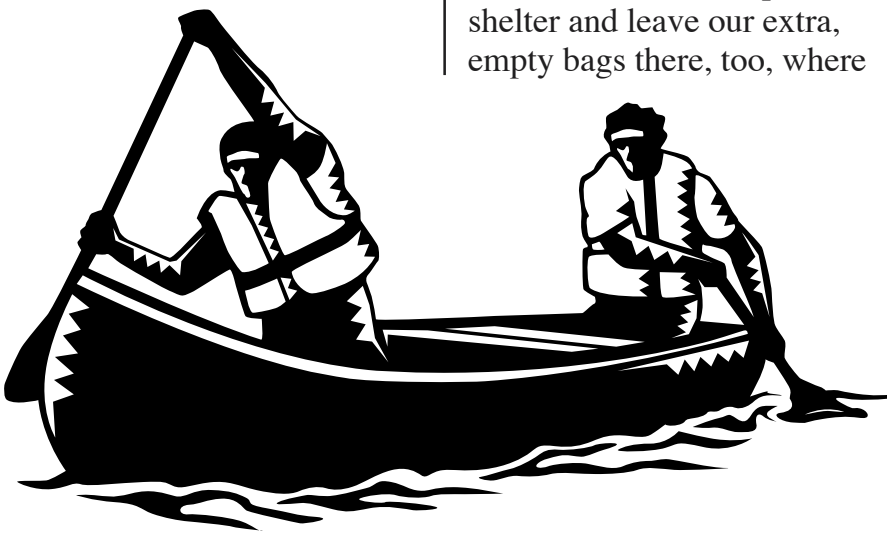
• "We discovered that much of the red clay we see along the shores of Lake Norman is the result of extensive farming practices that removed valuable topsoil from the land.

• "We learned that we are excellent topographic map readers and that urbanization can adversely impact water quality mainly due to the resulting runoff.

• "We learned that recreational activities can ruin the beauty and safety of a lake if people behave irresponsibly."

Discussion Questions:

Use the questions that follow to help you assess what students learned on the hike. Students can respond orally, or you can ask them to write their answers on paper. Assessment can be done at the park, if time permits, or back in the classroom.



1. Do the effects of dams upon water quality outweigh their benefits?

Answers will vary, according to students' beliefs. Encourage students to explain their answers by listing pros and cons.

2. How, if possible, can the effects of dams upon water quality be reduced?

(1) Control introduction of suspended solids or runoff through use of **silt** fences, watershed protection, etc., and (2) control activities on lakes to minimize turbidity, etc.

3. What does the absence or presence of certain aquatic organisms indicate about the quality of water?

In aquatic environments, the presence or absence of certain organisms, called **indicator species**, reveals much about the quality of the water. Water with a rich and varied range of aquatic creatures is usually a healthy environment, whereas water with just a few species usually indicates less healthy conditions.

4. When you are being a Lake Watcher and you discover very green water, what could that mean?

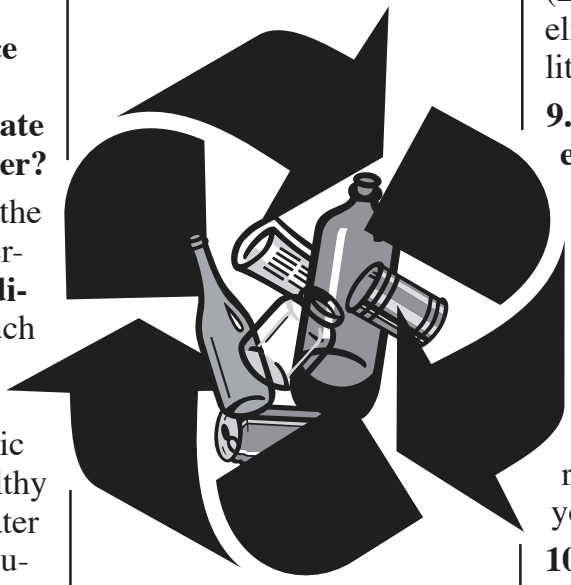
The water could be overpopulated with algae, possibly from too many fertilizers from agricultural runoff.

5. How about if you discover water that is a weak tea or coffee color?

In otherwise clear water, this dark color is an indication of the decomposition products of leaves and bark. This same color could also be an indication of chemical pollution.

6. What are some ways that residents, industries, farmers, etc., within the lake watershed can reduce their negative impacts on water quality?

(1) Control runoff from their property, (2) recycle used motor oil, (3) use biodegradable or "environmentally safe" cleaners, herbicides, etc., (4) maintain forested creek bottoms and other wetlands to filter runoff, and (5) prevent litter – recycle and dispose of trash properly.



7. What are some of the ways urbanization affects water quality?

(1) Removal of forests, which filter runoff and control erosion, increases pollution, (2) increased runoff comes from **impervious surfaces**, i.e., paved roads and parking lots, roofs, etc., and (3) introduction of treated wastewater that contains chemicals and nutrients pollutes the water supply. A less obvious answer might be that the increased air pollution from cars, trucks, industries, etc., contributes to **acid rain**.

8. What are some of the ways to reduce the effects of boats upon water quality?

(1) Properly maintain boats, (2) use extra care when refueling, and (3) always secure litter when boating.

9. As individuals, what can each of you do to control litter?

(1) Use trash cans, (2) participate in litter removal projects like Big Sweep, an annual volunteer effort to clean up the state's waterways, and (3) recycle as much trash as you can.

10. Why is water quality so important to wildlife?

Water is essential to all life. Organisms need clean water to breathe, drink, reproduce and grow.

Your Phrase to Remember:

"Earth is home to us all. Water is life to us all. Share it responsibly."

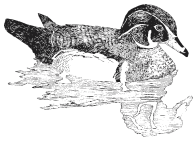
Alder Trail – Common Aquatic Plants and Wildlife

MAMMALS
- Muskrat

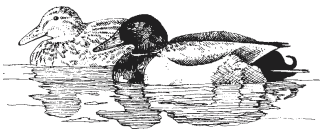
BIRDS
- Belted Kingfisher

- Great Blue Heron

- Wood Duck



- Mallard Ducks



TREES
- Smooth Alder

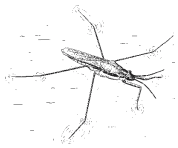
- River Birch

- Silky Dogwood

- Musclewood

OTHER PLANTS
- Cardinal Flower
- Giant Cane
- Rushes
- Grasses

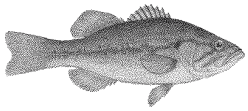
INSECTS
- Water Striders



- Dragonfly

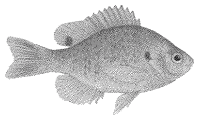
- Water Boatmen

FISH
- Largemouth Bass

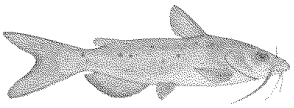


- Black Crappie

- Bluegill



- Channel Catfish



REPTILES
- Northern Banded Water Snake

- Painted Turtle

AMPHIBIANS
- Salamander

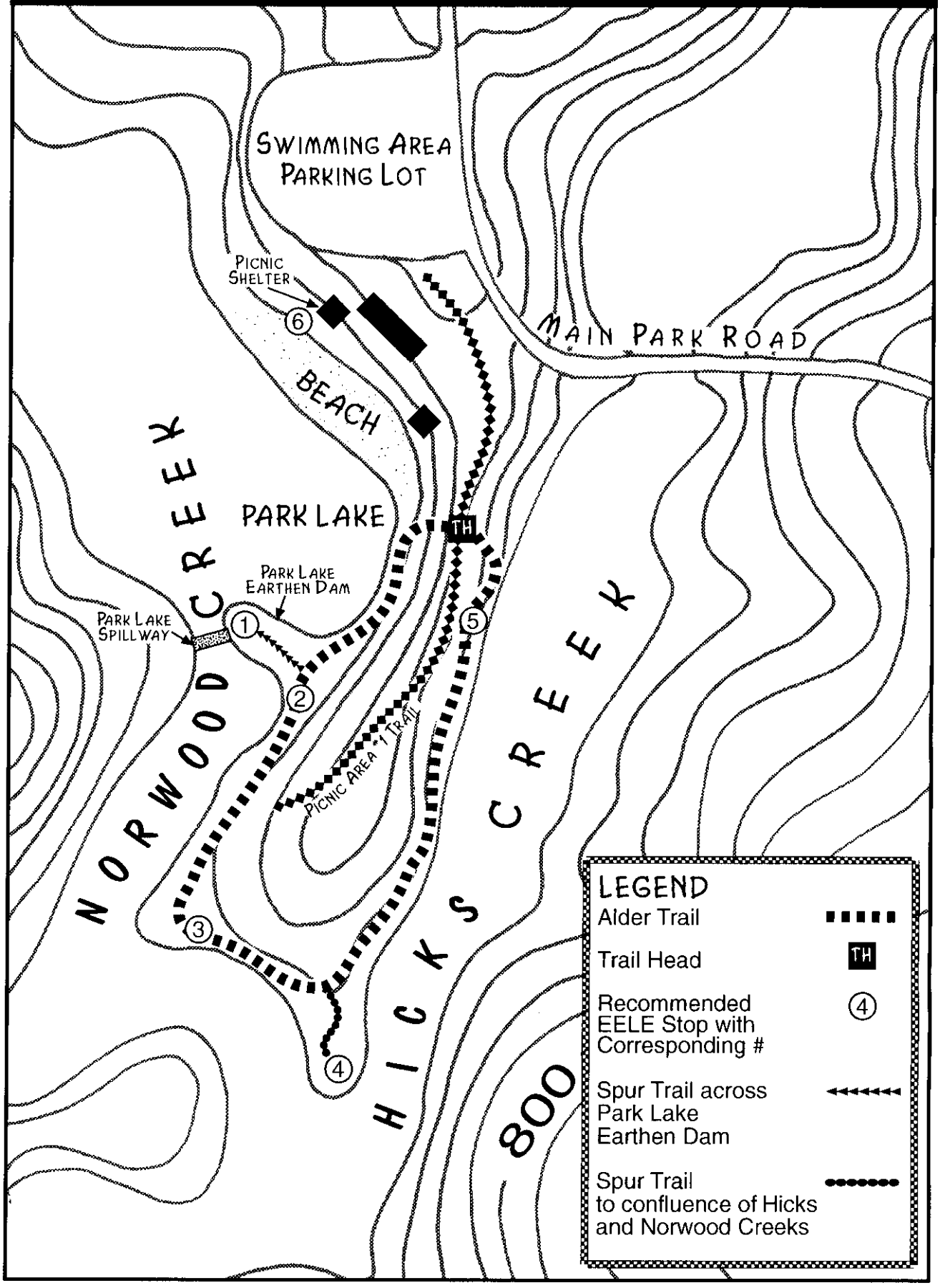
- Bull Frog

MISCELLANEOUS
- Bryozoan Colonies

Lake Watchers Investigation Chart

Observations . . .	Possible Cause
very green color	Water is overpopulated with algae probably due to excess nutrients from runoff.
reddish color	Water may contain excessive clay particles that have not settled out yet (high turbidity).
tan, murky color	May be the result of a heavy load of silt, a very fine-grained sediment, due to erosion.
yellow coating on stream bottom	Indication of sulfur entering the stream bed
white cottony masses on bottom	This could be "sewage fungus" — gross!
multicolored sheen	See if you can break it up with a stick. If so, it is caused by bacteria as they decompose natural materials. If not, it is caused by petroleum products entering the stream.
foam on the water	When white and thicker than three inches, it may be caused by detergents. Tan foam can be caused naturally due to minerals in the water.
Smells . . .	
rotten egg odor	Could be caused by natural decomposition in a swamp or marsh, or by sewage pollution if a marsh is not present.
musky odor	Could be caused by untreated sewage, livestock waste or harmful types of algae.
bleach odor	May indicate that a sewage treatment plant is over-chlorinating the water.
unusual chemical odor	A chemical may be leaking into the water from a nearby source. Be careful!

Lake Watchers Trail Map



Post-Visit Activity #1 — Park Lake

Major Concepts:
- Human impacts
- Water quality
- Land use issues
- Preservation of natural areas
- Stewardship

Learning Skills:
- Interpreting data, communicating, evaluating
- Organizing and analyzing information
- Problem solving and critical thinking skills

Subject Areas:
- Science
- Social Studies
- English Language Arts

* See the Activity Summary for a correlation with the DPI objectives in these subject areas.

Location: Classroom

Estimated Time: One to three 45-minute periods

Appropriate Season: Any

Materials:
Provided by educator:
Per student: One copy of Student's Information
Per three students: Scissors, masking tape, glue or paste, marking pens, paper, one copy each of Land Use Cut-outs and Park Lake Map (two pages)

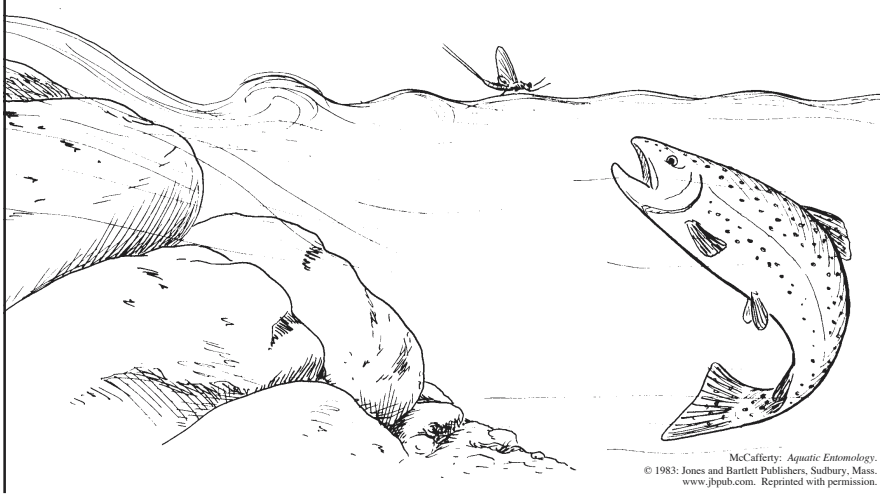
Credits: "Dragonfly Pond," *Project WILD Aquatic Education Guide* – 1987, 1992. Council for Environmental Education. Adapted with permission from Project WILD. In North Carolina, Project WILD is part of the N.C. WILD environmental education program. For information about N.C. WILD, contact the N.C. Wildlife Resources Commission, Division of Conservation Education, 1712 Mail Service Center, Raleigh, NC, 27699-1712.

Objectives:
- Evaluate the potential effects of different land uses on water quality and aquatic life in the park lake.
- List and describe at least five things we can do as individuals or societies to protect water quality.
- Create a land use plan for a small watershed that minimizes damage to water quality.

Educator's Information:

This activity is a simulation where students analyze the potential impacts of various land uses on the **aquatic** life and **water quality** of the park lake. Student teams will develop and defend land use plans for the park lake's **watershed**. They will also consider how their decisions affect aquatic resources in the **river basin** downstream.

If time permits, allow the students to do further research on new technologies to prevent polluted **runoff** and other types of water **pollution**. These technologies could be incorporated into their land use plans.



Instructions:

1. Prepare copies of the Land Use Cutouts and Park Lake Map (two pages) for student groups. Read and discuss the Student's Information with the class. Ask students to describe other land uses and give pros and cons of each. Put these other uses on the chalkboard or overhead.

2. Divide the class into groups of three or four students. Give each group a copy of the Park Lake Map (two pages), the Land Use Cutouts, tape, scissors and marking pens. Have the students tape the two sections of the Park Lake Map together. Then, have students cut out the land use pieces. Explain the following rules. You may want to put them on the chalkboard:

- In making their land use plans, students must use all the land use pieces. However, they can choose to make some of the pieces smaller – down to one half of their original sizes.

- None of the pieces can overlap, and all must be placed upstream above the state park boundary. No pieces can be placed within the park.

- Student teams can develop and label additional land use pieces if they desire.

- The goal is to place all the land use pieces where they will do the least amount of damage to the aquatic life and water quality of the park lake.

3. For older students, the teacher might ask each team to represent a specific interest group. For example:

A. Farmers - want to clear and use land to produce food, livestock and lumber.

B. Highway department - wants to build a highway through the area to provide access for fire, police and emergency medical services.

C. Permanent residents - want development, but not so much that their homes are affected by noise, traffic, pollution, etc.

D. Business interests - want to use the land for commerce and development (home builders, small businesses, restaurants, etc.)

E. Public services - want to build and operate a **wastewater treatment plant** in the area.

F. Adopt-a-Park group - wants to help preserve additional land for the state park.

4. Have students work in their teams long enough to begin serious debate over the land use decisions. Remind them that no land use can be excluded, but they can find ways to reduce the damage to the park lake. Have them lightly fasten the cutouts to the map with small loops of tape. This will allow them to change their minds before they stick the cutouts down permanently. They can use the marking pens to add things they think might help preserve water quality and protect plants and animals. For example, if polluted runoff is a problem, are there ways to reduce it and keep it out of the creek?

5. Give the students additional time, as needed, to come up with what they believe is the best land use plan possible. Ask groups to use glue or paste to permanently fasten cutouts to their maps. Be sensitive to their frustrations and display all the final land use plans in the classroom for all to see. Ask each group to present the highlights of its plan to the class. Analyze and discuss the merits of each plan. Point out that although the solutions may not be perfect, damage to the park lake watershed can be reduced.

6. Consider with them the idea that all the waters of the Earth are interconnected so that all land use activities affect many other things. Display one of the groups' maps on the chalkboard. Next, draw the rest of park lake connected to it. Label all the features as shown on page 5.1.9. What lies downstream from the park lake? (Answer: Norwood Creek, Hicks Creek and Lake Norman) How might these aquatic systems be affected by the activities in the park lake watershed? Note that all the pollutants

dumped into the park lake watershed will eventually flow downstream. Make inferences and predictions about the potential consequences of these activities.

7. Finally, ask students to create a list of actions that we can take as individuals or as societies to reduce the potentially damaging effects of our **lifestyles** on water quality. If possible, have students try some of these suggestions and report periodically on their progress in carrying them out. Remember, we all live downstream!

Assessment:

Create a map of an imaginary watershed, or use a map of an actual watershed. Ask students to indicate where they would site a variety of land uses from a list you supply. Students should write a sentence or two describing ways to reduce damage to water quality for each use.

After this exercise, if a real watershed map was used, show students where various land uses have actually been developed. Compare the locations of actual development with the locations suggested by the students.

Suggested Extensions:

1. As student teams develop their land use plans, ask them to do research to learn more about methods to control polluted runoff, such as **sediment** fences and vegetation buffers. Encourage them to incorporate these technologies into their land use plans.

2. If studying the atmosphere, ask students to do research to learn more about how land use plans might affect the airshed as well as the watershed. For example, removal of trees and the introduction of more homes, cars and industries will increase the amount of carbon dioxide and other greenhouse gases in the atmosphere.

3. Invite a guest speaker from a private organization that works to protect natural resources. Examples of organizations are the North Carolina Environmental Defense Fund, the Catawba Lands Conservancy and the North Carolina chapters of The Nature Conservancy and Sierra Club. Discuss "urban sprawl" – what it is and the possible impacts on water quality.

4. Organize a Stream Watch group in your community. Stream Watch groups "adopt" a waterway, or a portion of one, and act on its behalf. They take care of the waterway by monitoring water quality, providing educational programs, removing litter, etc. For more information on Stream Watch, contact: Stream Watch Coordinator, N.C. Division of Water Resources, 1611 Mail Service Center, Raleigh, NC, 27699-1611, (919) 733-4064.

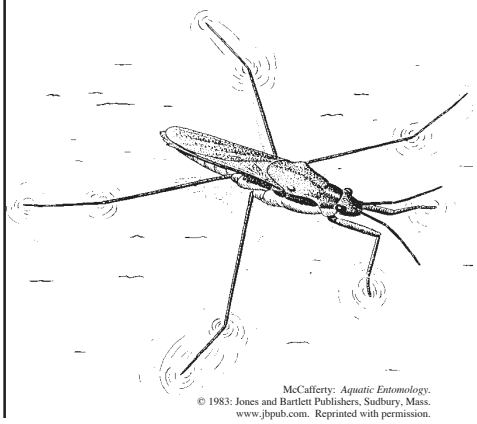
5. Collect newspaper articles for local water-related and land use issues as a current events activity.

6. Learn more about environmental impact statements. Try to obtain actual statements about natural areas in your region. See what concerns are addressed in these documents.

7. Find out about zoning laws and land use regulations in your area by contacting your city or county director of planning or zoning. Find out if the plan your group proposed for the park lake watershed would be allowed in your community.

8. Send a representative sample of the students' land use plans to the park. (We would appreciate the feedback.) Write to the Iredell County Planning Board about any concerns you have with the water quality of the swimming lake at Lake Norman State Park:

Planning Board, c/o Iredell County Planning Department, PO Box 788, Statesville, NC, 28677.



Student's Information

Think back to your visit to Lake Norman State Park. You learned that if the lake **water** can support a variety of plants and animals, it is also healthy for people. Good **water quality** is important to the many towns and cities that rely on water from Lake Norman for drinking, industrial uses and irrigation. Lake Norman is also used by many people for recreation – swimming, fishing and boating. What would happen if the water quality was damaged in Lake Norman and/or in the park lake?

The Lake Norman area is growing rapidly. Many people seek undeveloped land to build new homes and industries. This growth can help the local economy, but development within the lake's **watershed** can also damage water quality and destroy communities of plants and animals living in and around the lake. Different people have different ideas about how to best use the land and water in the Lake Norman watershed and still keep the water clean. Let's consider some of the pros and cons of different land uses:

Housing Developments

PRO

- Provide shelter for people.
- Provide jobs in construction and home maintenance.

CON

- Generate sewage and other wastes.
- Generate polluted **runoff** from yards and streets.
- Damage or destroy **habitats** for wildlife and plants.

Farms and Feedlots

PRO

- Produce food for people and animals.
- Provide lumber and wood products.
- Provide jobs.

CON

- Increase **soil erosion** – more **sediment** will enter lakes and streams.
- Use pesticides and herbicides that can get into **aquatic** systems where they poison wildlife and people.
- Increase nutrients in rivers and lakes from fertilizers and animal wastes.

Restaurants and Shops

PRO

- Provide jobs.
- Provide convenient locations for people to get food and other necessities.

CON

- Increase runoff from parking lots, roofs and other **impervious surfaces**.
- Generate waste and sewage that must be treated.
- Contribute to the loss of habitat and **natural communities.**

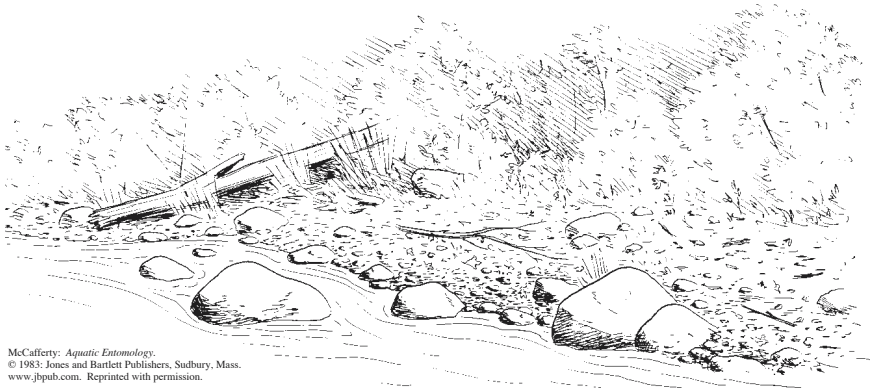
Wastewater Treatment Plants

PRO

- Remove disease-causing **organisms** from water.
- Provide jobs in construction, maintenance and operation of the plant.

CON

- Discharge **effluent** containing chlorine and nutrients into the water.
- Allow for more development – more homes, shops and industries.



McCafferty: *Aquatic Entomology.*

Highways

PRO

- Provide access to area for the public and for emergency medical services.
- Provide jobs in construction and maintenance of roads.
- Sometimes allow people to get to their homes and jobs faster.

CON

- Contribute to the loss of habitat and natural communities.
- Increase runoff due to impervious road surfaces.
- Increase soil erosion during road construction.
- Disrupt natural water flow and animal migration patterns.
- Increase sources of litter in the watershed.
- Require use of herbicides to maintain roadsides.

Laundromats

PRO

- Provide jobs in construction and operation.
- Provide a convenient place for people to wash their clothes.

CON

- May introduce significant amounts of polluted water into the watershed.
- Contribute to the loss of natural areas.

Gas Stations

PRO

- Provide jobs in construction, maintenance and operation.
- Provide convenient location for people to buy gas for their cars, boats, etc.

CON

- Increase runoff that will contain pollutants such as gasoline and oil.
- May contaminate **groundwater** from leaking underground storage tanks.
- Contribute to the loss of natural areas.

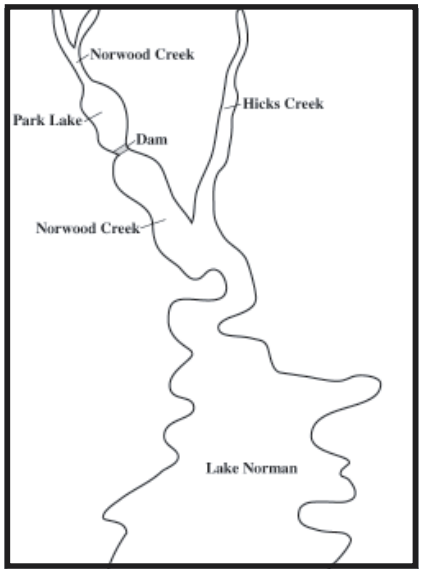
Parks, Greenways and Natural Areas

PRO

- Provide outdoor recreation opportunities such as hiking and nature study.
- Provide protection of watershed, natural communities and habitats.
- May bring tourist dollars into the local economy.

CON

- Remove lands for possible development (i.e. agriculture, forestry, industry, etc.)
- Require management, upkeep and protection.

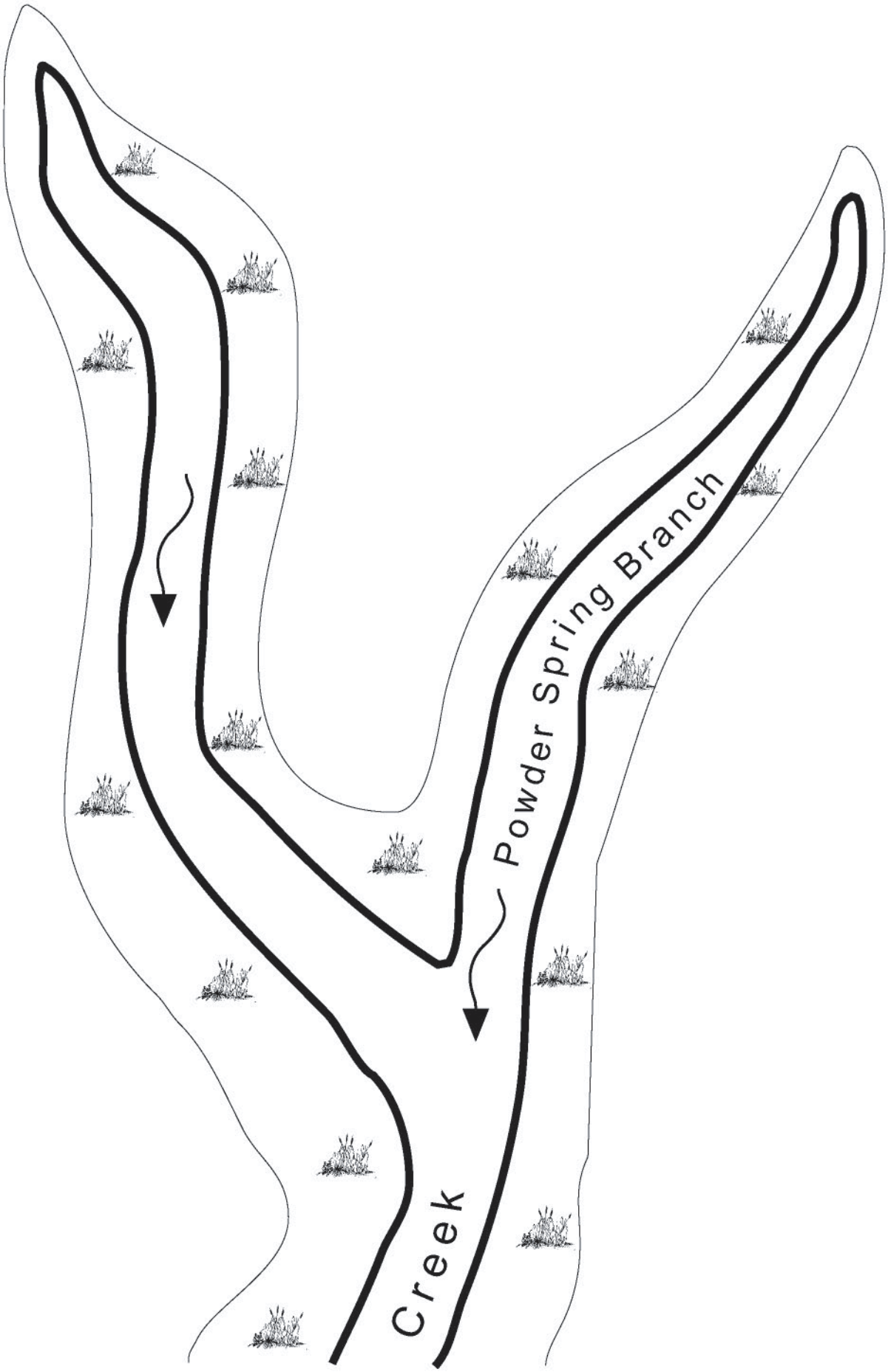


Other Land Uses

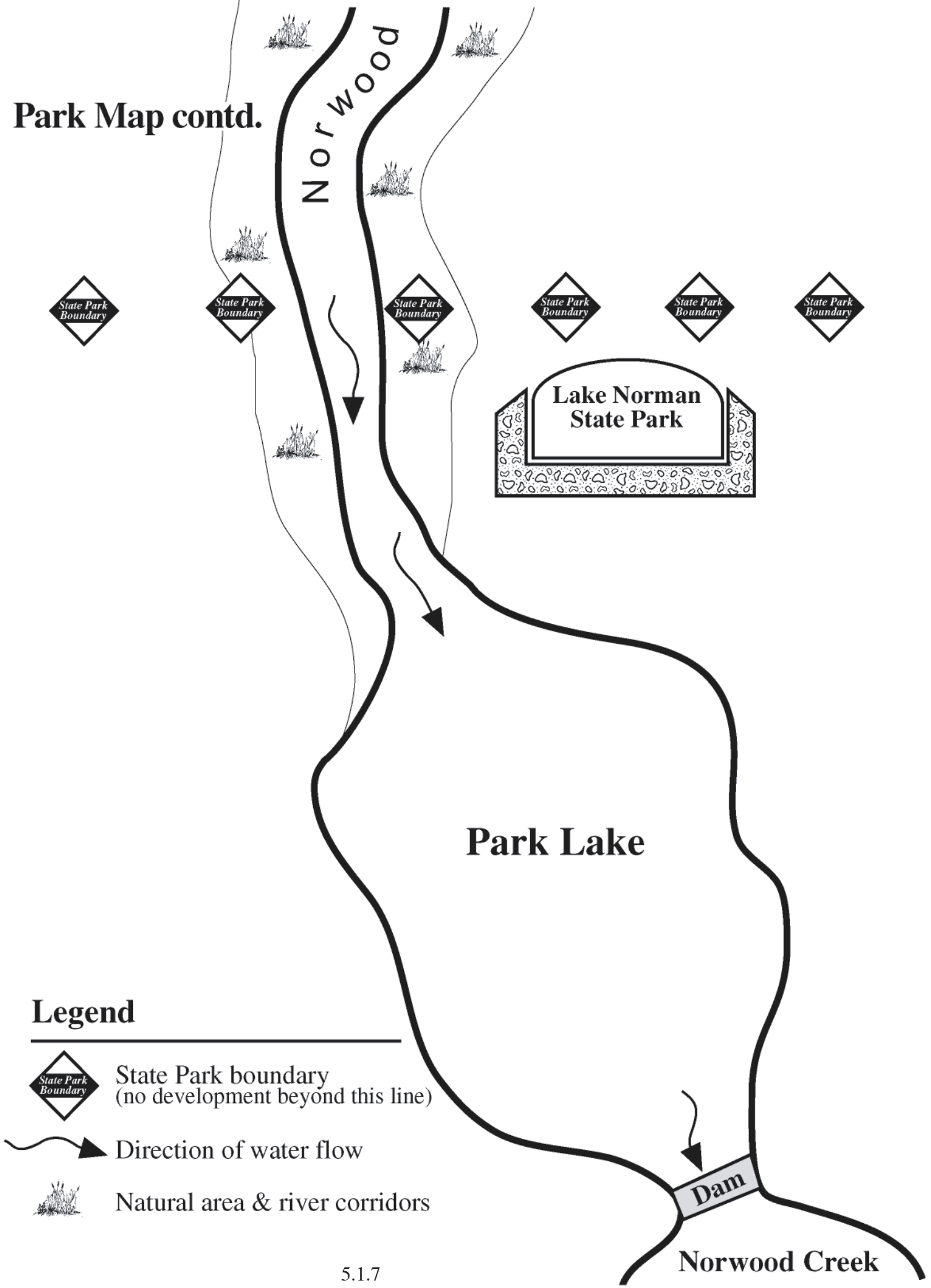
Can you think of other land uses? What are their pros and cons?

In the following activity, you will work with other students to develop a land use plan for the park lake watershed. Think about how you can include various land uses while, at the same time, protecting water quality in the park lake and downstream in the **river basin**. This can be a difficult and challenging job – see how creative you can be. Remember, we all live downstream!

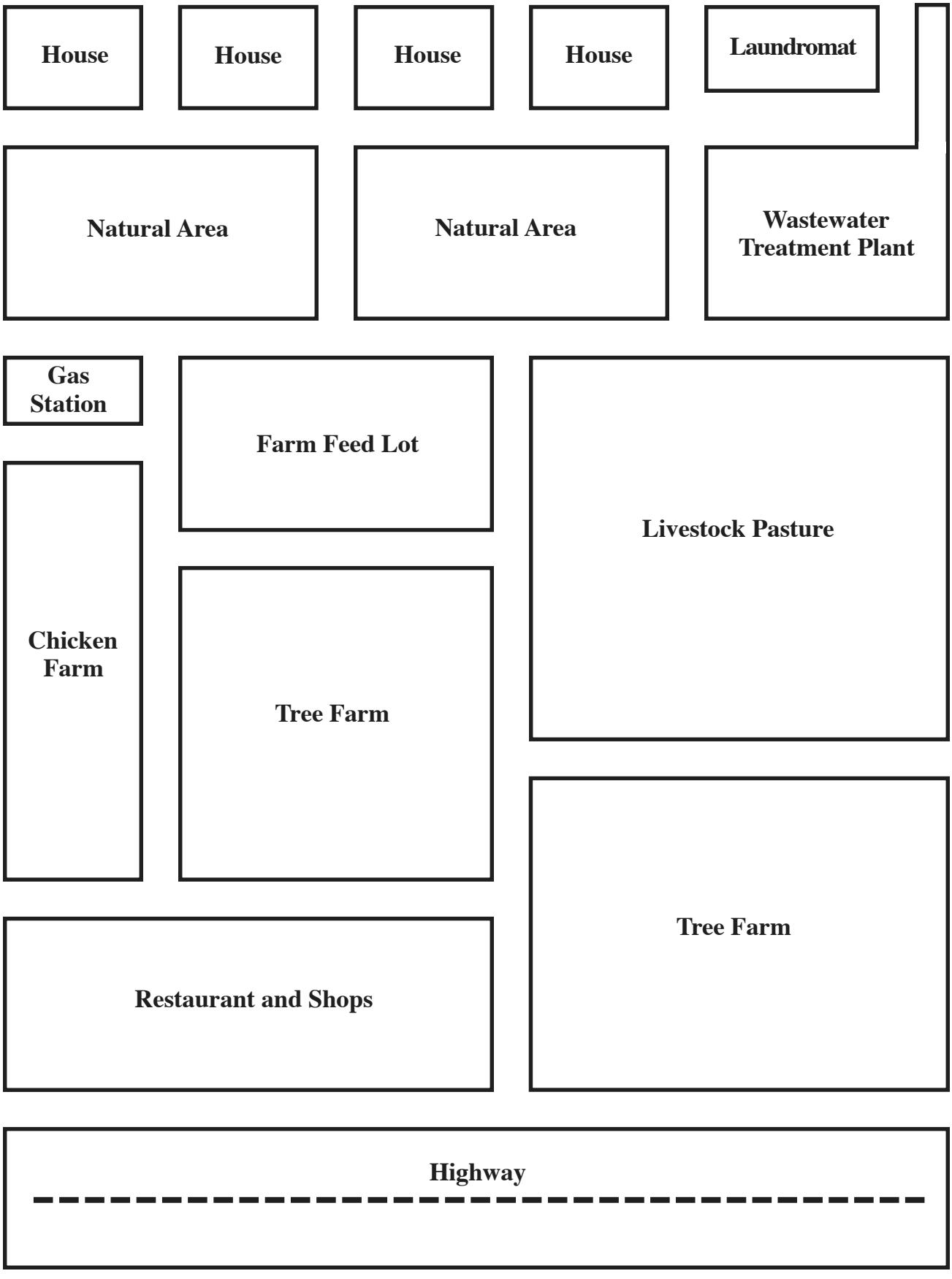
Park Lake Map



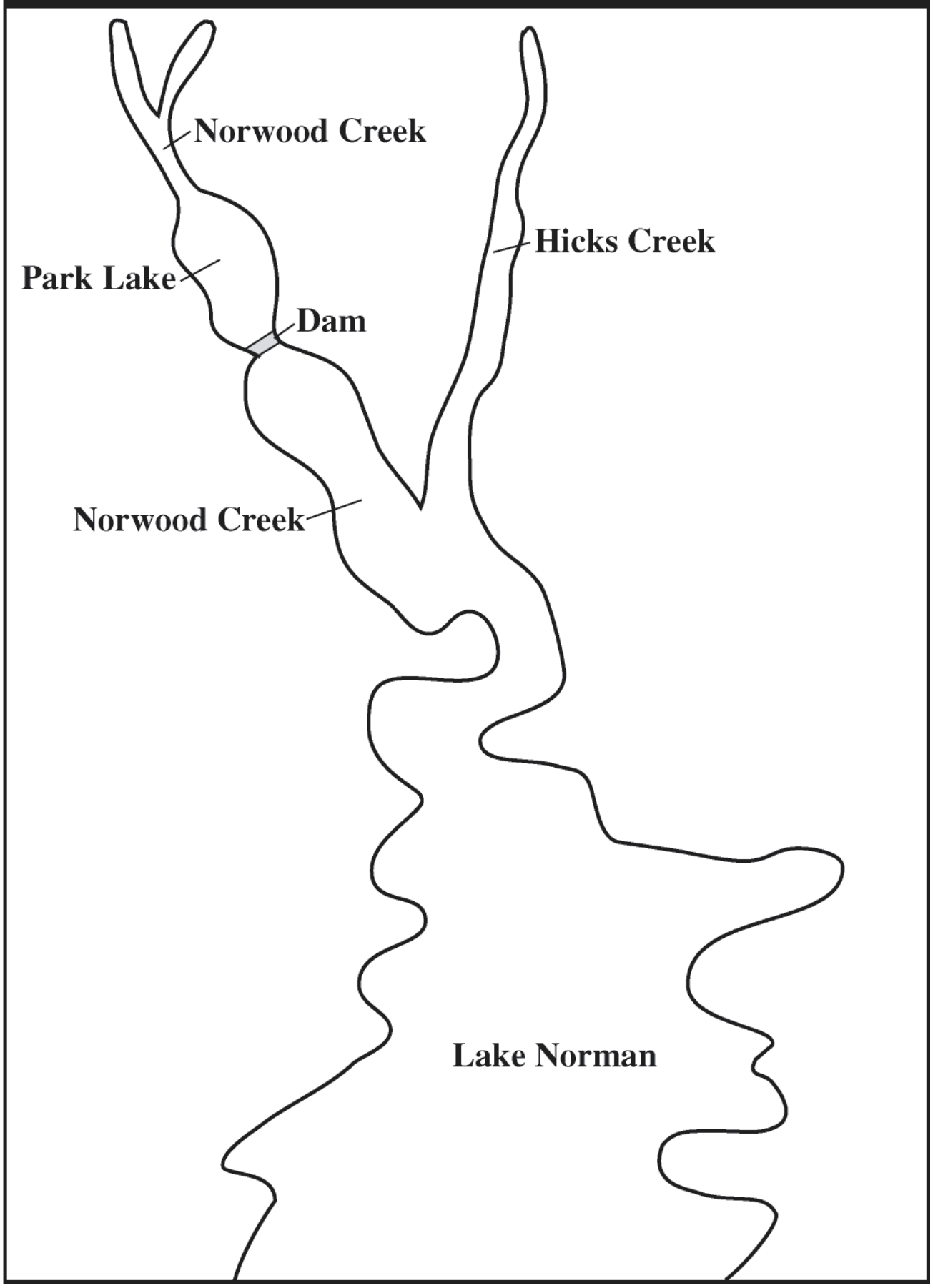
Park Map contd.



Land Use Cutouts



The Rest of Park Lake



Post-Visit Activity #2 — Guilty or Innocent?

Major Concepts:
- Water quality
- Environmental ethics
- Polluted runoff

Learning Skills:
- Inferring and elaborating
- Communicating ideas verbally and through art

Subject Areas:
- English Language Arts
- Social Studies
- Science

* See **Activity Summary** for a correlation with DPI objectives in these subject areas.

Location: Classroom

Group Size: 25 - 30

Time: One hour with additional time for exploring water pollution in the community and creating posters.

Materials:
Provided by educator:
Per student: Student's Information, Guilty or Innocent? (two pages), pencil, posterboard

Per class: Paints, crayons and/or colored markers

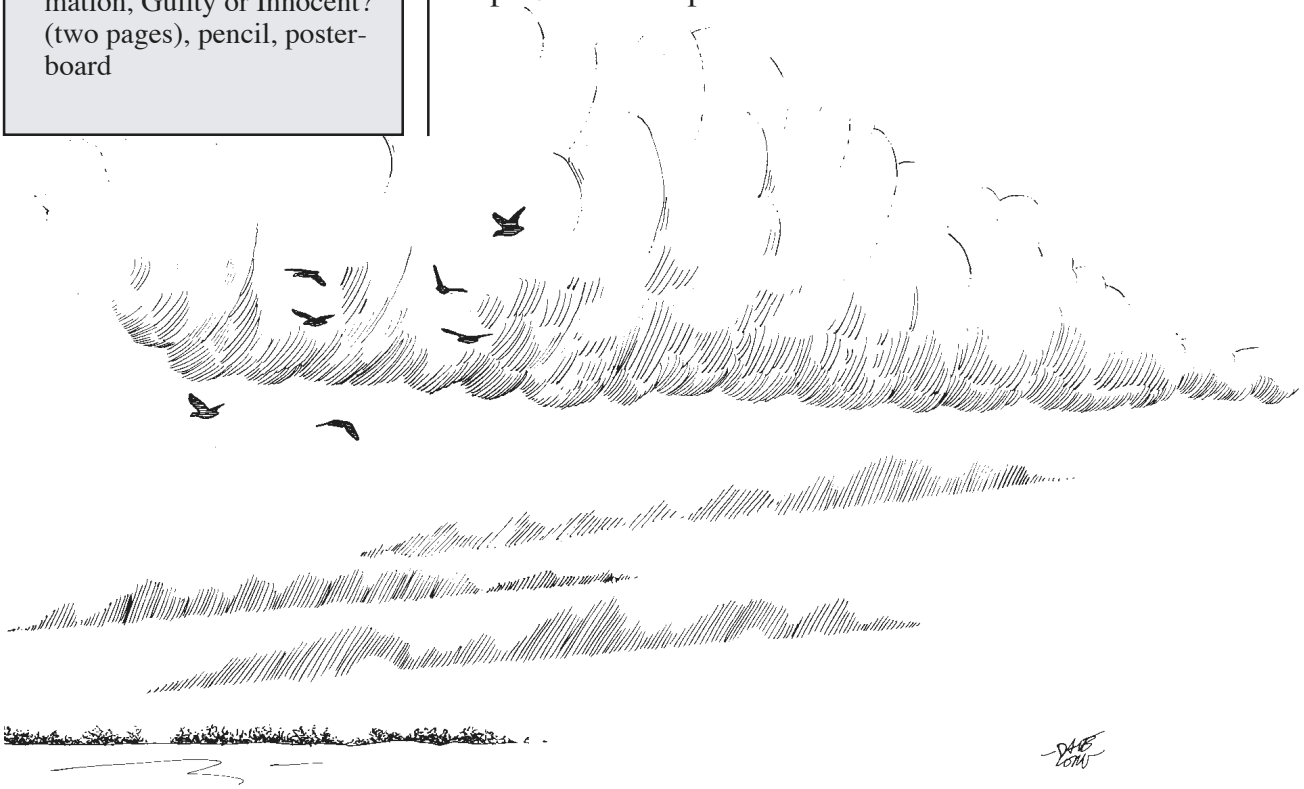
Credits: Adapted with the permission of the National Wildlife Federation from the *Pollution: Problems & Solutions* issue of *Ranger Rick's NatureScope*. Additional information from "What's Up with Our Nation's Waters?" (booklet #841-B-01-004) from the U.S. Environmental Protection Agency.

Objectives:

- Describe at least five ways that average citizens might contribute to water pollution.
- Identify at least five things people can do to help prevent water pollution.

Educator's Information:

In this activity, students will discuss ways that water becomes polluted and learn how average citizens can contribute to water **pollution**, often without realizing it. Students will read about the activities of fictional characters and decide whether they are guilty or innocent of polluting the water. Students will also discuss ways they personally can reduce water pollution. They will create posters to raise awareness about what every individual can do to help protect **water quality**.



Instructions:

1. Begin the activity by asking the students to name some ways that water gets polluted. Write their ideas on a chalkboard, easel or overhead projector. Ask them if they think they are guilty or innocent of polluting their water. Who do they think is most responsible for water pollution?

2. Give each student a copy of Guilty or Innocent?, page one, and explain that the facts on this page are all related to water pollution. The students will use these clues to decide if certain people are innocent or guilty of polluting the water. Ask students to skim the page and underline any terms that are unfamiliar. Go over these terms.

3. Next, provide each student with a copy of Guilty or Innocent?, page two. On this page, students will read about the actions of five fictional characters. They should study each description and use the clues from page one to decide whether or not each character is guilty or innocent of polluting the water.

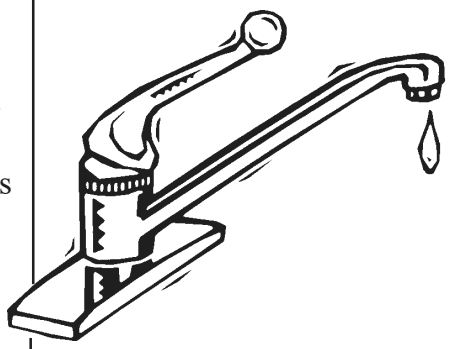
4. The students should write "guilty" or "innocent" on the line above each person's name on page two. On the back of their papers, students should write a short explanation of why they think each person is guilty or innocent. Tell them to include the numbers of the clues from page one that helped them reach their decision.

5. When everyone is finished, go over page two with your students. Use the answers on the answer sheet and background information provided in the Student's Information. Be sure to explain that some of the actions of the people on page two might not affect overall water quality very much by themselves. However, if a lot of people in the area were doing the same things, the cumulative effect could be disastrous. Unfortunately, this is exactly what happens in many communities throughout North Carolina and the rest of the United States.

6. Discuss with your students the fact that, like the characters in the story, we are all guilty of polluting water, often without knowing it. Every time we flush our toilets, wash our clothes, take showers and do any number of activities that require using water, we contribute to water pollution problems.

7. Ask the students if they'd like to add any other sources of water pollution to their initial class list. Use the Student's Information or other resource materials to help students create a more complete list.

8. Point out that there are many things we can do to reduce the amount of water pollution we create. Ask the students what the characters on page two might do to reduce their effects on water quality. Here are some suggestions:



Joe – use fewer and less-toxic pesticides, or he might use natural insect predators to help control pest insects. He could also make sure his cows graze away from the stream.

Leila – use collecting pans to catch liquids emptying from the car. She could take used motor oil and antifreeze to a collection center for recycling or to a hazardous waste collection center. She could soak up any spilled liquids with cat litter and then take the litter to a hazardous waste collection center.

Lee – switch to nontoxic lawn care. He might also consider learning about xeriscaping so that he could provide landscaping options

that require less water and fewer chemicals than grass does.

Martha – periodically check her underground storage tank for leaks. She could upgrade the tank so it doesn't corrode.

Amy – use smaller amounts of detergents and cleaning products. She could also use less toxic cleaning products such as baking soda and vinegar. She should avoid using all that bleach, especially if she has a septic tank.

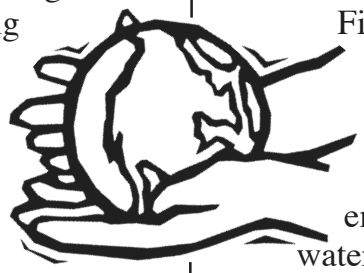
9. Use the Student's Information or other resource materials to help students make a list of the actions all of us can take around our homes to reduce water pollution. Ask each student to illustrate one method of preventing water pollution on a piece of posterboard. An alternative to drawing might be writing an essay, poem or story to illustrate the importance of protecting water quality. Display the posters or essays around the school. Encourage all the students to work together to reduce pollution in the **river basin** that includes your school or city.

Assessment:

Ask students to write down at least five sources of water pollution. Next to each source, they should explain in one sentence how they can help to reduce or prevent this type of pollution in their river basin.

Student's Information

Water pollution is a global issue. It is easy to understand that a crippled tanker leaking millions of gallons of crude oil into the ocean is polluting the water. But big industry cannot take all the blame. We are each responsible to some extent for all forms of pollution. And, individual citizens can make a positive difference. There are many simple things we can do around our homes and in our **lifestyles** to reduce pollution and improve **water quality**.



Ruinous Runoff

Whenever it rains, many pollutants end up in our streams, lakes and waterways. One of the biggest pollutants carried in **runoff** is **soil** or dirt. When soil is washed into streams and rivers, it smothers small animals and kills any fish eggs clinging to rocks. Dirt can also suffocate fish by clogging their gills. Look for bare patches in your yard that might be contributing to ruinous runoff. Plant some trees or use other types of ground cover to keep your soil in place.

Almost anything we spray, dump, or spill on the ground can end up in our waterways. Pesticides, chemical fertilizers, animal wastes and other compounds may flow directly into waterways or wash down storm drains.

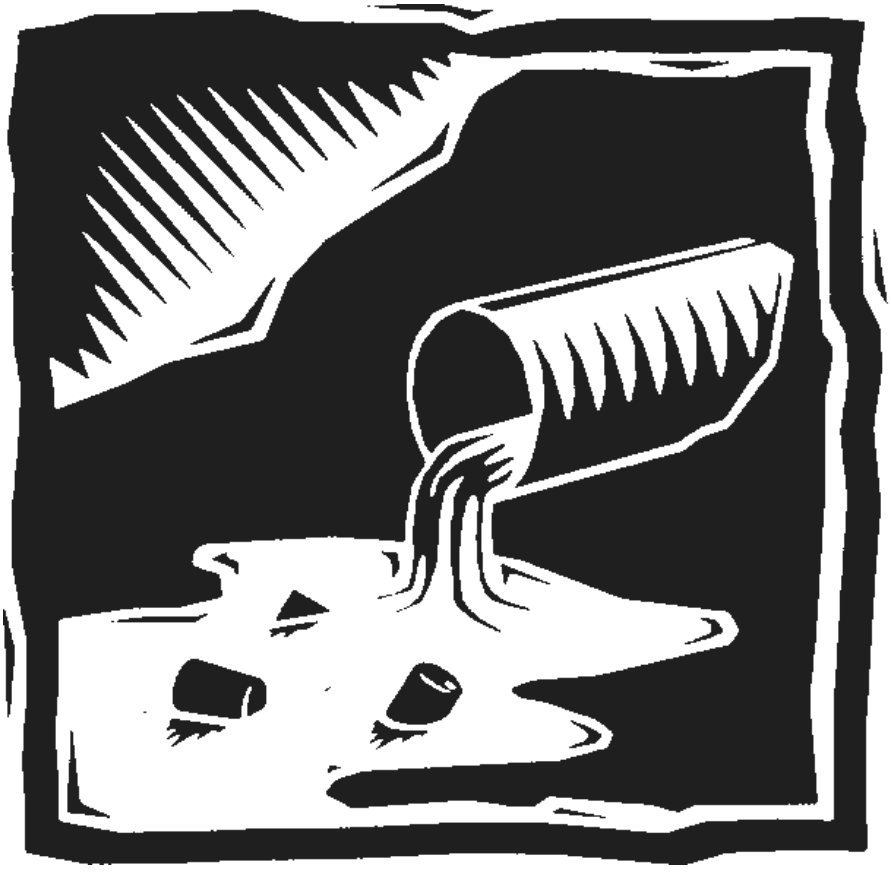
Find out where the water in your storm drain goes. Most storm drains empty directly into waterways. This untreated stormwater can carry all kinds of bacteria and chemicals harmful to people and other forms of life.

Car Care

A car engine can hold four to six quarts of oil. If this oil is dumped down a storm drain, it can end up in a nearby waterway. Just one quart of oil can create an oil slick that contaminates up to two million gallons of drinking water! Other car products, including antifreeze, are also toxic and may poison dogs and cats if they drink the water on your driveway. Or, if these chemicals are washed into a nearby stream, they can kill **aquatic** animals.

Down the Drain?

The stuff most people wash down their sink drains and toilets goes to a **sewage** treatment plant before it's released into rivers or other water-



ways. These plants can remove many of the pollutants in wastewater, including food and other organic waste. However, treatment plants can't remove all the hazardous materials. Watch what you wash down your drain! Paints and other household chemicals do not belong in your drain. Bring them to a hazardous waste collection site in your county.

Groundwater Pollution

There are approximately five million underground storage tanks in the United States. More than 200,000 of them may be leaking. These tanks are used to store gasoline, oil, chemical waste and other hazardous liquids. Most of the tanks are made of steel, which can corrode, and often develop leaks after 20 to 30 years. Leaks in underground tanks and the pipes that lead to them are one of the most common sources of **groundwater** pollution. If you have an underground tank, have it inspected for leaks. Remember that any materials you spray, dump or spill on the ground can soak into the soil and pollute the groundwater.

Air Pollution = Water Pollution

In most of the United States, cars are the major means of transportation. They are also one of the major causes of air pollution. Every day, millions of people drive to and from work, school, church, shopping centers, etc., all the while emitting a gaseous pollutant called nitrogen oxide into the air. When it rains, nitrogen oxide combines with water to produce **acid rain**, snow or fog. Acid rain damages many plants and raises the acidity level in lakes, rivers and streams, which can hurt aquatic life. Try to combine your trips so that you do not use your car as much. Ride a bicycle or walk whenever you can.

Electric Pollution

Most of the electricity people use in the United States comes from power plants that burn coal or oil. Burning these fossil fuels contributes to acid rain and other kinds of air pollution. The extraction of these fuels from the ground can harm natural areas and result in runoff problems. When rain runs off land that's been disturbed by bulldozers and other heavy equipment, it picks up dirt and **silt** and carries them into surface water. The more electricity we use, the more water and air pollution we create. What are some ways you can conserve electricity?

Off the Streets

Oil, dirt, litter and anything else that's on the streets wash into storm drains. In most areas of the country, these drains empty into a series of underground pipes that eventually dump directly into waterways. Join with others to clean up litter before it reaches our water.

Trashing the Water

When trash gets thrown overboard it can create an ugly mess – both in the water and on shore after it's washed up. Trash can also harm or even kill wildlife. For example, thousands of sea birds, sea turtles and marine mammals die each year after eating or becoming entangled in plastic debris floating in the ocean. Make sure you don't contribute to this problem. Help keep our beaches and waterways clean.

Be on the lookout for other ways that water can become polluted. Learn as much as you can so that you can help protect the water. Remember, if you pollute the water, you actually pollute yourself!

Guilty or Innocent?

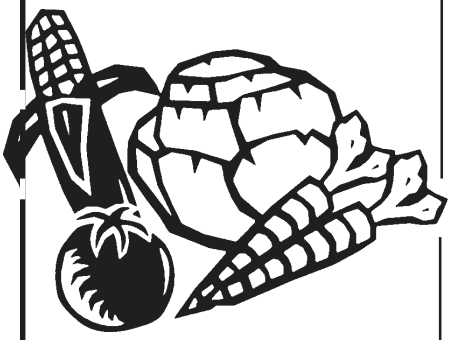
PAGE ONE

1. Rainwater that washes off the land often flows directly into streams, lakes and other waterways.

2. Most storm drains dump untreated water directly into rivers, wetlands, sounds or lakes.

3. Underground gasoline or oil storage tanks often develop leaks after 20 to 30 years.

4. In most areas of North Carolina, whatever goes down people's toilets and sinks either travels to a septic tank or to a sewage **(wastewater) treament plant**.



5. Crops grown with a lot of pesticides often look "perfect."

6. Sewage treatment plants treat waste water by removing disease-causing organisms and food waste. Then the plants release the treated water into rivers, streams and other waterways.

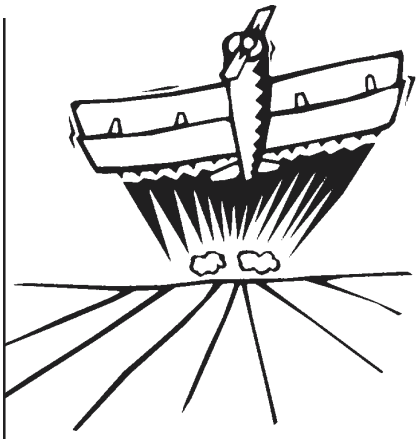
7. Septic tanks sometimes leak, especially if they are not well maintained.

8. During floods or other times of high water flow, sewage treament plants may not be able to process and treat all the waste water.

9. Most sewage treatment plants can't remove all the chemicals in waste water, such as those found in many household cleaning products.

10. Fertilizers, pesticides, road salt, animal waste, car fluids and other materials that wash into waterways can poison aquatic plants and animals and/or decrease the amount of oxygen in the water.

11. When substances soak into the soil, they can contaminate groundwater. This includes substances in trash that is buried in landfills.



12. Thick, green lawns often get that way through the use of chemical fertilizers and pesticides.

13. Many pollutants found in the air eventually make their way into our water.

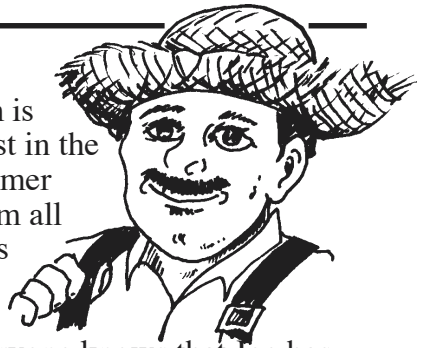
14. North Carolina banned the use of phosphates in detergents in 1988. Phosphate is a fertilizer that can cause **algae blooms**.

Guilty or Innocent?

PAGE TWO

Two days ago, the city water inspector discovered pollutants in Fourth Creek, located just east of town. A short time later, she found contaminants in several private wells. Using the clues from Page One, can you figure out which of these area residents might have contributed to the problem?

JOE RAMOS

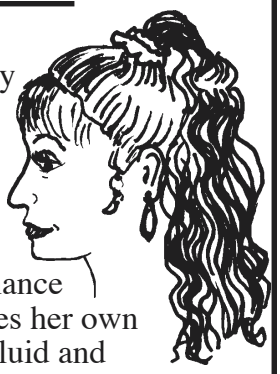


Joe Ramos' farm is one of the biggest in the area. In the summer people come from all over to buy fruits and vegetables from Joe's produce stand. Everyone knows that Joe has some of the most beautiful produce around – it's almost always free of insect damage. Kids love to come to the stand with their parents because they get a chance to see Joe's cows with their calves in the field next to Fourth Creek.

MARTHA STONE

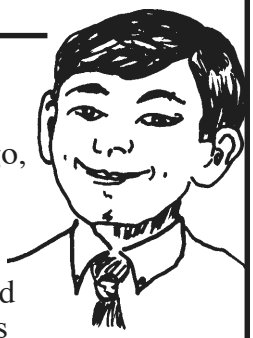
Martha Stone's small gas station east of town has become a landmark in the area. Every day Martha is there selling gas, snacks and ice-cold sodas. Anyone who goes into the station is sure to get an earful of stories about what life used to be like. First-time visitors to the station almost always get a tour of it, starting on the sidewalk above the underground storage tank. Here Martha shows people where she carved her initials and the year "1953" into the wet cement the day before the station opened.

LEILA KHALIL



Leila is a senior at the city high school. A year ago she bought a car with money she'd saved from her part-time job. Since then she's learned to do most of the car's maintenance work herself. She changes her own oil, maintains the wiper fluid and changes the antifreeze. After Leila works on her car she cleans up, pouring her used motor oil down the storm drain and hosing down her parent's driveway.

LEE AKIZA



When he started his lawn-care company five years ago, Lee Akiza had no idea it would become so successful. In a recent interview about his company, Lee said he was sure his success was due to his special training programs in which he teaches his workers how best to apply fertilizers and weed killers. Mr. Akiza also said he's proudest of the thick, green grass that grows on the golf course at the local country club, which is taken care of by his company.

AMY KAROWSKI

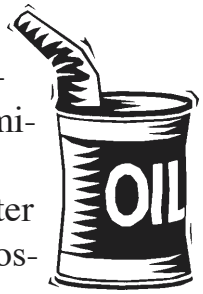
Amy Karowski is a full-time homemaker with three dogs and three children who like to play football, soccer and baseball. She spends a lot of time washing dirty uniforms, cleaning house and walking the dogs! In fact, the clerk at the supermarket often teases Amy about the huge boxes of heavy-duty detergent, the gallons of bleach and other household cleaning products she buys.

Guilty or Innocent? Answer Sheet

(Fact numbers are listed in parentheses.)

Joe Ramos – guilty. To grow "perfect" fruit and vegetables, Joe most likely uses lots of pesticides (5). Rainwater may wash these chemicals into waterways where they can poison aquatic organisms (1,10). The pesticides may also contaminate groundwater (11). Also, Joe keeps cows in a field right next to Fourth Creek. The cows' waste may wash into the creek (10).

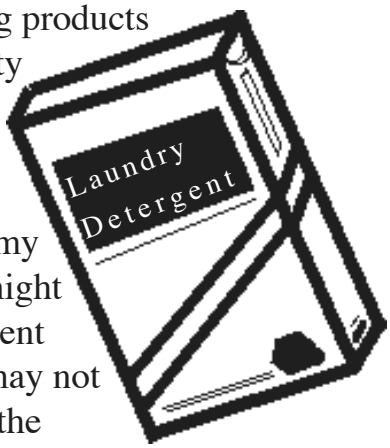
Leila Khalil – guilty. When Leila dumps her used motor oil down the storm drain, it eventually flows into a waterway (2). Once in the water, the oil can poison aquatic animals (10). In addition, if Leila lets any chemicals soak into the soil, they can contribute to groundwater pollution (11). When she hoses down her parents' driveway, the water may carry more waste into storm drains and then directly into waterways (2,10).



Lee Akiza – guilty. Lee most likely uses chemical fertilizers and pesticides to make lawns become thick and green (12). Rainwater may wash these chemicals into waterways (1, 2) where they can cause problems for aquatic organisms (10). Some of the chemicals may soak into the soil and contaminate groundwater (11).

Martha Stone – guilty. Martha Stone's gas station has an underground gasoline storage tank that is more than 30 years old (3). If gasoline is leaking from the tank, it could pollute the groundwater (11). In addition, any fluids that drip off cars in Martha's parking lot could be washed down storm drains and into waterways (2), damaging the water quality (10).

Amy Karowski – guilty. Although North Carolina does not allow the sale of detergents with phosphates, other chemicals in Amy's cleaning products can cause water quality problems. The dirty water from her washing machine, or other cleaning water that Amy puts down her sink, might go to a sewage treatment plant (4). The plant may not be able to remove all the chemicals (9) before discharging the water back into a river. Or the detergents and bleach could end up in her septic tank (4), which may be leaking (7). Either way, the chemicals could eventually make their way to a stream or river where they could damage water quality (10). If Amy throws old cleaning products into her trash, the chemicals could leak in the landfill and cause groundwater pollution (11). Finally, what does Amy do with all her pets' wastes? During a heavy rain, the wastes could run off the land and into a creek (1, 2), polluting the water (10).



Post-Visit Activity #3 Pollution Dilution

Major Concepts:
- Water pollution
- Watershed
- Point pollution
- Nonpoint pollution

Learning Skills:
- Interpreting data, communicating
- Organizing and analyzing information
- Graphing

Subject Areas:
- Science
- Social Studies
- English Language Arts
- Mathematics
- * See Activity Summary for a correlation with DPI objectives in these subject areas.

Location: Classroom

Group Size: 30 or smaller

Time: 1 - 1 1/2 hours

Materials:
Provided by the educator:
Per class: Nine different colors of construction paper (two sheets of each color), colored markers, scissors
Per team: One Pollution Graph, tape (or glue), plastic container for simulated water sample, fact sheet for their assigned lake and Water Sample Analysis Sheet
Per student: One copy each of Types of Pollution sheet and Student's Information

Credits: "Deadly Waters," *Project WILD Aquatic Education Guide* – 1987, 1992. Council for Environmental Education. Adapted with permission from Project WILD. In North Carolina, Project WILD is a part of the N.C. WILD environmental education program. For more information on N.C. WILD, contact the Conservation Education Division, N.C. Wildlife Resources Commission, 1712 Mail Service Center, Raleigh, NC, 27699-1712.

Objectives:

- List at least four major types of aquatic pollution.
- Given a list of pollutants in a water sample and a description of land use in a watershed, make inferences on the probable causes of the pollution in the sample.
- Predict the potential effects of a variety of aquatic pollutants on wildlife and people.

Educator's Information:

In this activity, the students will become familiar with the major types of **aquatic pollution** and will predict the potential effects of a variety of aquatic pollutants on wildlife and people. Each team will receive a small container with different amounts of colored paper squares. The container represents a water sample from an imaginary lake; the paper squares represent different types and amounts of water pollutants in their lake. The students will graph the data from their sample and use a fact sheet about their lake to help them make inferences about the probable causes and severity of pollution in their lake. Using the Types of Pollution sheet and Student's Information, the teams will predict the potential effects of specific types of water pollutants on people and wildlife. The teacher should read and study the Student's Information and Types of Pollution sheet as background information.

Instructions:

1. First, prepare the simulated water samples for the student teams. It is recommended that each team have two to four members to ensure a high level of student participation. These instructions contain directions on preparing water samples for *four* imaginary lakes. You could make two water samples for each lake so that you would have a total of eight water samples (eight student teams). Although the samples for a given lake will be identical, the two student teams may differ in their interpretation of the data. This would be an excellent opportunity to demonstrate the probabilistic nature of science.

2. Using nine different colors of construction paper, cut out half-inch squares so that you have the number of squares per color as listed below. *Remember to double the numbers if you are preparing two samples for each imaginary lake*. The colors represent the categories of water pollution found on the Types of Pollution sheet. If you need to substitute a different color for one of the colors below, please correct the color name on the Types of Pollution sheet before photocopying it.

Green: 23 (Double = 46)

Brown: 19 (Double = 38)

Yellow: 16 (Double = 32)

Pink: 17 (Double = 34)

Black: 15 (Double = 30)

Light Blue: 12 (Double = 24)

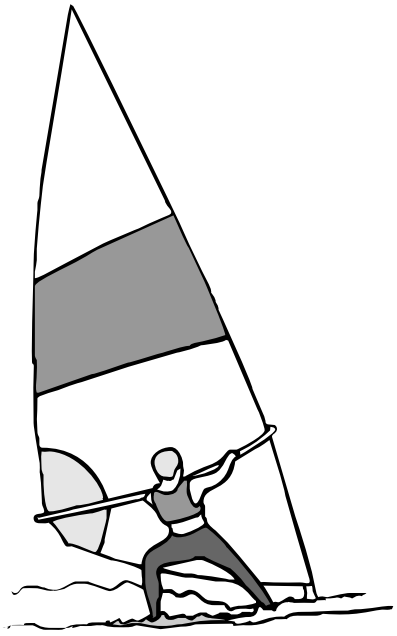
Red: 8 (Double = 16)

Orange: 15 (Double = 30)

Dark Blue: 26 (Double = 52)

3. The "recipe" for the water sample from each imaginary lake is given below. If you are making two water samples for each lake, you will need a total of eight containers. You could cut old two-liter drink bottles in half and use the bottom half as a container. Label each container with the name of one of the lakes. Place the colored paper squares in each container as called for in the "recipe."

Lake Ipecac: Dark Blue - 12, Yellow - 2, Green - 7, Pink - 5, Black - 3, Brown - 2, Light Blue - 4, Red - 1, Orange - 3.



Lake Chickamonga: Yellow - 6, Dark Blue - 5, Green- 4, Brown - 4, Pink - 4, Black - 3, Light Blue - 2, Red - 1, Orange - 4.

Lake Lapihiho: Green - 7, Brown - 11, Yellow - 4, Pink - 4, Black - 3, Dark Blue - 4, Light Blue - 2, Red - 2, Orange - 5.

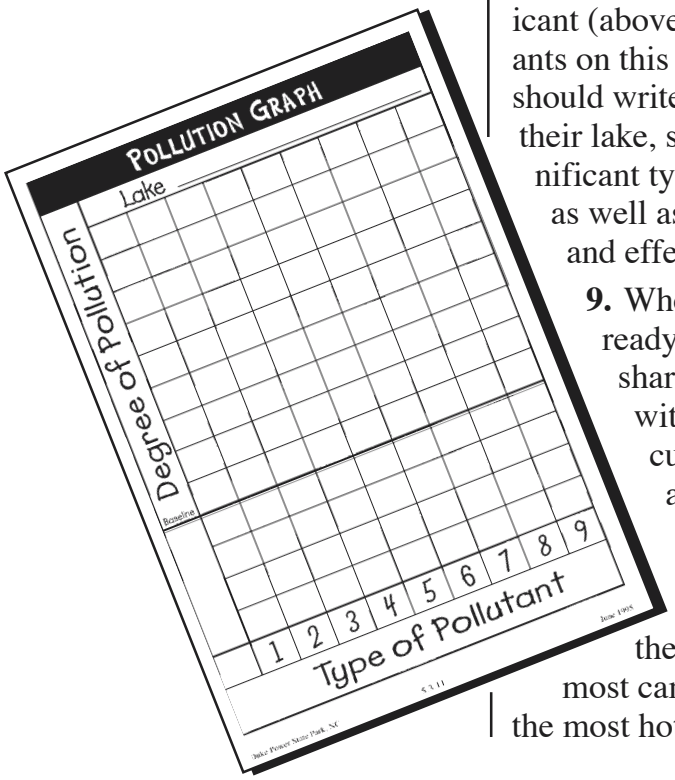
Lake Rockameenie: Black - 6, Green - 5, Brown - 2, Yellow - 4, Pink - 4, Dark Blue - 5, Light Blue - 4, Red - 4, Orange - 3.

4. Make one copy of the Student's Information and Types of Pollution sheet for each student. Make one copy *per team* of the fact sheet for their lake, the Water Sample Analysis Sheet and the Pollution Graph.

5. To begin the activity, ask students to call out examples of different types of water pollution. List their examples on the board or overhead. Then give each student a copy of the Types of Pollution sheet. Have the students compare their examples with the pollution types listed on the sheet. Are there any new terms, or types of pollution, that are unfamiliar to the students? Also read and discuss the Student's Information sheet so that students are prepared to begin analyzing their simulated water samples.

6. Divide the students into research teams. Give each team a simulated water sample, Pollution Graph and tape (or glue). Explain that the different squares represent different types of pollution in their water sample. The students should use the Types of Pollution sheet to match the colored squares with the different types of pollution. Explain the graph, emphasizing that the numbers along the bottom correspond to the numbered pollutants on the Types of Pollution sheet.

7. Instruct the students to remove the paper squares from their water sample and glue or tape them in the appropriate location on the graph. The graph will provide a good visual representation of the whole array of pollutants in their lake. Explain that anything below the baseline on the graph represents an acceptable level of pollution, not likely to be dangerous to humans or wildlife. (It is nearly impossible to have perfectly clean water!) However, the fact that a pollutant is present should cause some concern. The pollutants below the baseline should be carefully monitored over time to make sure they don't become a problem in the future.



8. When each team has finished their graph, give them the fact sheet for their lake and a Water Sample Analysis Sheet. The fact sheet will describe their watershed and the types of human activities that occur there. The team should use the Water Sample Analysis Sheet as a graphic organizer to help them organize their inferences and predictions. An example is provided on the sheet. The students will list only the significant (above baseline) pollutants on this sheet. Each team should write a brief report on their lake, summarizing significant types of pollution as well as possible sources and effects.

9. When the teams are ready, ask them to share their summaries with the class. Discuss the similarities and differences between the four lakes. Why did the lake with the largest city, the most campgrounds and the most hotels in its watershed (Lake Rockameenie) have *less* pollution than some of the others? Did they consider the size of the lakes and the dilution factor? What pollutants would be likely to cause the *most* damage to **natural communities**, wildlife **habitat** and people? Give examples and discuss the kinds of damage that could be caused. How could the pollution in each lake be prevented? If two teams analyzed the same lake, compare their presentations. Were their inferences and predictions exactly the same? Why or why not? Is it possible that there could be several logical causes or sources for one type of pollution? What further testing could be done to find the actual cause?

Assessment:

Create a fact sheet and water sample for your own fictitious lake. Ask students to analyze the sample, graph the pollutants and write predictions regarding the possible effects of the pollution on people and wildlife.

Suggested Extension:

Create a circle graph for each lake that shows the proportion of various pollutants in the water sample. Using facts from the lake's fact sheet, illustrate each lake and its watershed on poster paper. Display posters with their accompanying graphs.

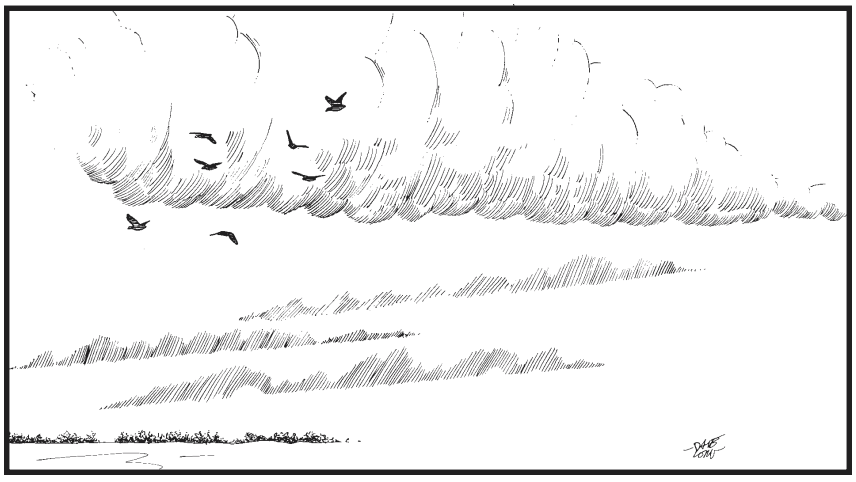
Student's Information

All the **water** that has ever been available to our planet is on, or in, the Earth right now. On the entire planet there are 326 million cubic miles of water. If the Earth were the size of a beach ball, 28 inches in diameter, all of the water on the planet would fill less than a cup. Most of the water in that cup would be salt water. Less than one drop would represent the fresh water contained in rivers and lakes!

Our supply of fresh water is fragile. Yet every day water is being damaged by **pollution**, and most of the pollution is caused by people and their activities. There are many different types of pollution. Several major kinds are listed on the Types of Pollution sheet that you will be using with this activity.

Scientists divide water pollution into two major categories: point and nonpoint. **Point pollution** comes from a localized source and is fairly easy to pinpoint. An example would be a specific type of chemical that is being used or made by a factory. The factory may be the only source of that particular chemical in the **watershed**. If we found this chemical in the water, it would be very likely that the factory was the cause. We could prevent further pollution from this chemical by ordering the factory to stop discharging it into the water.

Nonpoint pollution is harder to pinpoint. Nonpoint pollution enters the water from a variety of sources that may be hard to identify. For example, rain can wash motor oil leaking from cars in many parking lots into storm drains. Eventually, this polluted **runoff** can make its way into the city's water supply. Because it's impossible to pinpoint all the sources of motor oil in the watershed, this nonpoint pollution is much harder to manage than point pollution.



When significant amounts of water pollution are discovered in a city's water supply, scientists and law enforcement officials work together to find the cause. In the case of point pollution, the person or persons responsible must pay a fine for the damage done to other people and to **aquatic** wildlife. In the case of nonpoint pollution, we are all responsible and so we all must play a role in correcting the problem.

In this activity, you will work with other students to analyze a water sample from an imaginary lake. Your teacher will give your team a water sample along with a fact sheet that describes the watershed surrounding your lake. You and your team will work together to identify the kinds and amounts of water pollutants in your sample. Then you will use your fact sheet and your detective abilities to suggest possible causes of the pollution in your lake. It could be from point sources or nonpoint sources. Your teacher will give you a Water Sample Analysis Sheet that will help your team organize your clues. Finally you will present your analysis to the class. You will include ways that you think the water pollution in your lake could affect people and wildlife. Good luck!

TYPES OF POLLUTION

1. DOMESTIC SEWAGE

Color: Green

Human waste (sewage) that is not properly treated at a **wastewater treatment plant** and then released into the water supply may contain harmful bacteria and viruses. Typhoid fever, polio, cholera, dysentery (diarrhea), hepatitis, flu and common cold germs are examples of diseases caused by bacteria and viruses in contaminated water. Sewage can be accidentally discharged from **septic systems** or wastewater treatment plants. People can come into contact with harmful microorganisms by drinking polluted water, through swimming or fishing in polluted water or by eating shellfish from polluted water.

2. FERTILIZERS & ANIMAL WASTES

Color: Brown

A major source of pollution comes from surplus fertilizers in runoff from farm fields, feed lots, golf courses and lawns. Fertilizers contain nitrogen and phosphorous that can cause large amounts of **algae** to grow. The large **algae blooms** cover the water's surface. The algae die after they have used all of the nutrients. Once dead, they sink to the bottom where bacteria feed on them. As the bacteria feed on the dead algae, bacterial populations can become so large they use up most of the **dissolved oxygen** in the water. When this happens, many aquatic animals that need oxygen die.

Another type of fertilizer, animal waste, also pollutes the water. Unexpected flooding of barnyards or stock pens (used for raising cattle and other animals) can increase the toxic effects of animal waste in water. Animal wastes also act as a fertilizer and can cause algae blooms, just as chemical fertilizers do. In urban areas, pet waste can be a significant contributor to water pollution.

3. INDUSTRIAL ORGANIC WASTE

Color: Yellow

Food processing plants, paper mill plants, leather tanning factories and other industries release **organic** wastes that bacteria consume. Organic materials come from once-living plants and animals. If too much waste is released, the bacterial populations increase and use up the dissolved oxygen. Fish die if too much oxygen is consumed by decomposing organic matter.

4. SEDIMENTS

Color: Pink

Particles of **soil**, sand, **silt**, clay and minerals wash from land and paved areas into creeks and **tributaries**. In large quantities, these natural materials can be considered pollutants. Construction projects often contribute large amounts of **sediment** to waterways. Certain lumbering and farming practices allow for greater amounts of sediments in runoff. Sediments may fill stream channels and harbors that later require dredging. Sediments suffocate fish and shellfish populations by covering the fish nests and clogging the gills of bottom fish and shellfish.

5. PETROLEUM PRODUCTS

Color: Black

Oil and other petroleum products like gasoline and kerosene can find their way into water from ships, oil drilling rigs, oil refineries, gas stations and streets. Oil spills kill aquatic life (fish, waterbirds, shellfish and vegetation). Birds are unable to fly when oil coats their feathers. Shellfish and small fish are poisoned. If oil is washed on the beach, it requires much labor to clean up. Fuel oil, gasoline and kerosene may leak into **groundwater** through damaged underground storage tanks.

Types of Pollution, continued

6. INDUSTRIAL CHEMICALS — Color: Dark Blue

Detergents, heavy metals and many manmade industrial chemicals are released into waterways. They often come from manufacturing and mining industries, oil field operations and other sources. These chemicals interfere with natural stream purification, and many are toxic to fish and harmful to humans. They cause taste and odor problems with the water and often cannot be treated effectively. Some of these chemicals are very poisonous in small amounts. They also corrode expensive water treatment equipment and increase the cost of boat maintenance.

7. ACID PRECIPITATION — Color: Light Blue

Aquatic animals and plants are adjusted to a rather narrow range of **pH** levels. pH is a measure of the acidity of a solution. When water becomes too **acidic**, due to industrial chemical pollution or **acid rain**, fish and other **organisms** die. Acid rain is caused by car exhaust and smoke from coal-fired power plants. The smoke from an erupting volcano can also cause acid rain.

8. HEATED OR COOLED WATER — Color: Red

The hotter the water, the less dissolved oxygen it can hold. Electric power plants use large amounts of water to cool the steam turbines. The heated water is often returned to streams, lagoons or reservoirs. With less oxygen in the water, fish and other aquatic life can be harmed. Water temperatures that are much lower than normal can also cause **habitat** damage. Deep dams often let extra water flow downstream. When the water comes from the bottom of the dam, it is much colder than normal.

9. PESTICIDES, HERBICIDES, FUNGICIDES — Color: Orange

Agricultural chemicals designed to kill or limit the growth of organisms are a common form of pollution. By limiting the growth of undesirable species (i.e. weeds, insects, fungi), they help to increase crop production. These chemicals are also used on golf courses and in people's yards to get rid of weeds. Irrigation, groundwater flow and natural runoff bring these toxic substances into rivers, streams and lakes. Here they can kill aquatic plants and animals. Some of these chemicals are also known to cause cancer in humans.

Fact Sheet for Lake Ipecac

Size: Small, normally holds 40 billion gallons of water. Has 100 miles of shoreline.

Number of counties in watershed: Four.

City wastewater treatment plants discharging into lake: Four.

Industry in watershed with own wastewater treatment facilities discharging into lake:

- Machinery company.
- Oil company.
- Trucking company.
- Hosiery mill.
- Chemical company.
- Fruit product company.
- Clothing industry.
- Chainsaw manufacturer.

Development on lake:

- Eighty percent of shoreline is developed, mostly with homes using septic systems.
- Two medium-size cities and several medium-size towns in watershed.
- Several shopping centers in watershed.
- One private campground on lake with its own wastewater treatment facility.
- One public beach with septic system.
- Five large motels with own wastewater treatment facilities.

Recreational use: Used for boating, fishing and swimming.

Marinas on lake: Five.

Agriculture: Little agriculture in watershed.

Fact Sheet for Lake Chickamonga

Size: Large, normally holds 200 billion gallons of water. Has 480 miles of shoreline.

Number of counties in watershed: Six.

City wastewater treatment plants discharging into lake: Three.

Industry in watershed with own wastewater treatment facilities discharging into lake:

- Large paper mill.
- Steel corporation.
- Furniture factory.

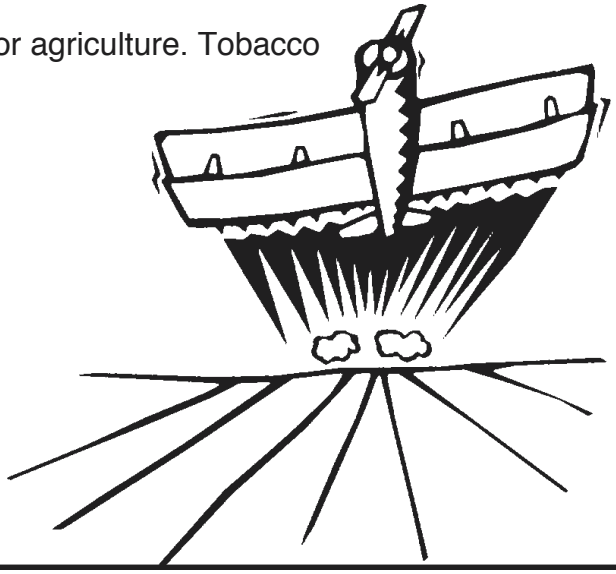
Development on lake:

- Forty percent of shoreline is developed, primarily with homes using septic systems. Many homeowners are there on weekends only.
- Two small cities and several small towns in watershed.
- A few shopping centers in watershed.
- Five private campgrounds on lake with septic systems.
- No public beaches on lake.
- Four large motels with own wastewater treatment facilities in watershed.

Recreational use: Used extensively on weekends for boating, swimming and fishing.

Marinas on lake: Eight.

Agriculture: Much land in watershed used for agriculture. Tobacco is primary crop.



Fact Sheet for Lake Lapihiho

Size: Small, normally holds 35 billion gallons of water. Has 95 miles of shoreline.

Number of counties in watershed: Three.

Agriculture: Much farming upstream of the lake – chicken farms, livestock and thousands of acres of corn crops.

City wastewater treatment plants discharging into lake: One.

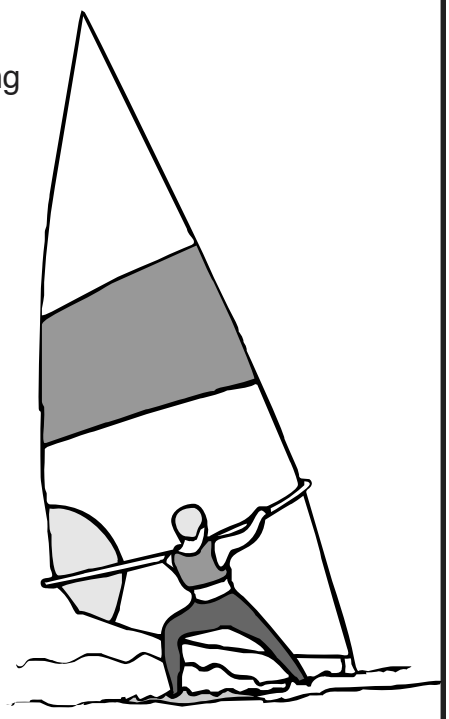
Industry in watershed with own wastewater treatment facilities discharging into lake: Fiberboard industry.

Development on lake:

- Thirty percent of shoreline is developed, mostly with homes using septic systems.
- One medium-size city and several small towns in watershed.
- Several shopping centers in watershed.
- Two public campgrounds on lake with septic systems.
- One public beach on lake with septic system.
- Three motels with own wastewater treatment facilities in watershed.
- One rest home with on-site wastewater treatment plant.
- One race track with on-site wastewater treatment plant.

Recreational use: Used extensively for boating, swimming and fishing. Heavy day use.

Marinas on lake: Three.



Fact Sheet for Lake Rockameenie

Size: Very large, normally holds 300 billion gallons of water. Has 500 miles of shoreline.

Number of counties in the watershed: Eight.

City wastewater treatment plants discharging into lake: Six.

Industry in watershed with own wastewater treatment facilities discharging into lake:

- Foam products industry.
- Large food processing plant.
- Leather tannery.
- Yarn mill.

Development on lake:

- Sixty-five percent of shoreline is developed, mostly with homes using septic systems. Many residents live there year round.
- One very large city, one medium-size city and several medium-size towns in watershed.
- Several shopping centers in watershed.
- Ten large privately-owned public campgrounds on lake with their own wastewater treatment facilities discharging into lake.
- Two public beaches on lake with septic system.
- Ten motels with own wastewater treatment facilities in watershed.

Recreational use: Used extensively for boating, swimming and fishing. Heavy day use.

Marinas on lake: Fifteen.

Agriculture: Not extensive.

Other:

- Rock quarry in watershed.
- Twenty percent of watershed involved in timber harvesting.
- Coal-fired steam plant on lake that burns 20,000 tons of coal a day and uses lake water as a cooling agent.

Water Sample Analysis Sheet

Lake _____

IDENTIFY: Significant Types of Pollutants (above baseline)	INFER: Possible Sources	PREDICT: Potential Effects on Wildlife and People (social, economic, health)
Example: Petroleum	• *Runoff from streets* • *Oil company*	• *Fish die* • *Money lost to local bait shops that sell to fishermen*

Pollution Graph

Lake _____

Degree of Pollution

Baseline

	1	2	3	4	5	6	7	8	9

Type of Pollutant

Vocabulary

Acid rain - Rain, or other precipitation, with a pH less than 5.6, resulting from atmospheric moisture mixing with sulfur and nitrogen oxides emitted from the burning of fossil fuels. It may cause damage to buildings, car finishes, crops, forests and aquatic life.

Acidic - Having a pH less than 7; the chemical state of water or another substance in which the hydrogen (H+) ions exceed the hydroxyl (OH-) ions. For example, a car's battery acid has a pH of 1. See pH.

Adaptation - A change in the function or structure of a plant or animal that allows it to adjust to its environment.

Algae - Simple, one-celled or many-celled plants capable of photosynthesis. They are usually aquatic and have no true root, stem or leaf.

Algae bloom - A heavy growth of algae in and on a body of water. It usually results from high nitrate and phosphate concentrations entering water bodies from farm fertilizers and detergents. Phosphates are also naturally occurring in some rock formations, such as those found in eastern North Carolina.

Anatomy - The branch of biology that deals with the structure of plants and animals.

Aquatic - Living or growing in water.

Aquatic index - The relative health of a water body. It is based on the tolerance or sensitivity of macroinvertebrates to changes in water quality. It is calculated using a simple formula.

Basic - Having a pH greater than 7; the chemical state of water or another substance in which the hydroxyl (OH-) ions exceed the hydrogen (H+) ions. For example, soap has a pH of 10. See pH.

Biology - The science that deals with the origin, history, physical characteristics, life processes and habits of plants and animals.

Classification - The grouping of organisms into categories based on shared characteristics or traits. For example, any animal that has feathers is considered a bird and placed in Class Aves. If the bird has its eyes in front rather than on the side of its head, it is a member of Order Strigiformes (owls).

Condensation - The process by which a vapor becomes a liquid.

Consumer - An animal that uses a producer or another consumer as its food. For example, a rabbit is a *primary* consumer because it eats green plants (producers). A fox is a *secondary* consumer because it eats rabbits (consumers).

Decomposer - A plant or animal that feeds on dead materials and causes their mechanical or chemical breakdown.

Detritus - Dead organic matter, such as fallen leaves, twigs and other plant and animal material that exists in any ecosystem.

Dichotomous - Divided into two parts, groups or classes, such as a dichotomous key. Using a dichotomous key, one can identify an unknown organism by following the one branch of each pair that best describes the organism.

Distribution - The act of scattering or spreading out; the geographic range of an organism.

Dissolved oxygen (DO) - The amount of oxygen gas molecules dissolved in water. Fish and other aquatic animals depend on DO to breathe.

Ecology - The science of the relationships between organisms and their environments.

Ecosystem - Plants, animals and their physical surroundings that interact with environmental conditions, such as temperature and rainfall, forming an interdependent system.

Effluent - A liquid flowing out. The outflow of a sewer, septic tank, etc.

Erosion - The removal or wearing away of soil or rock by water, wind or other forces or processes.

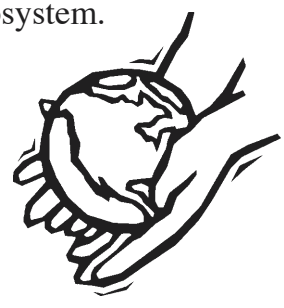
Eutrophication - Naturally occurring changes that take place after a water body receives inputs of nutrients, mostly nitrates and phosphates, from erosion and runoff of surrounding lands. This process can be accelerated by human activities.

Evaporation - The conversion of a liquid (water) into a gas (water vapor), usually through the application of heat energy.

Food chain - The transfer of energy and material through a series of organisms as each one is fed upon by the next.

Food web - The interlocking pattern of food chains that exist in an ecosystem.

Genus - The taxonomic category located between species and family.



Groundwater - Water that fills the spaces between rocks and soil particles underground. Groundwater is replenished when rainwater trickles through the soil. Surface water, such as lakes and rivers, is often replenished by groundwater.

Habitat - The environmental conditions of an area where a plant or animal naturally grows or lives; its environment.

Impervious surface - A surface that doesn't absorb water, such as a paved parking lot.

Indicator species - An organism whose presence or absence in a particular environment can be used to determine the health of that particular environment.

Insect - Any animal in the Class Insecta. It has a head, thorax, abdomen and three pairs of legs on the thorax. As an adult, it usually has one or two pairs of wings attached to the thorax as well.

Irrigation - The pumping of water from ponds, lakes or rivers through pipes or canals to supply crops or livestock with water during periods of dry weather.

Key - An ordered list of significant characteristics of a group of organisms. A key is used to identify unknown species.

Larva - (larvae, plural) The immature form of an animal that changes structurally when it becomes an adult, usually by *complete* metamorphosis.

Lifestyle - A way of life, including attitudes, values and priorities.

Macroinvertebrate - *Macro* means "large;" *invertebrate* means "without a backbone." These small animals are usually large enough to be seen without the aid of magnification.

Metamorphosis - *Meta* means "change;" *morphe* means "form." A change in form, structure or function as a result of development. A physical transformation undergone by various animals during development from the larval stage to the adult form. For example, through metamorphosis, a hellgrammite (larval form) becomes a dobsonfly (adult form). The change from a tadpole (larval form) to a frog (adult form) is another example of metamorphosis.

Mussel - Any of the various freshwater or saltwater bivalves, which are animals with two shells held together by a strong muscle.

Natural community - A group of plants, animals, bacteria and fungi that are naturally associated with each other and their physical environment. Scientists often name a natural community for its most common or dominant plants.

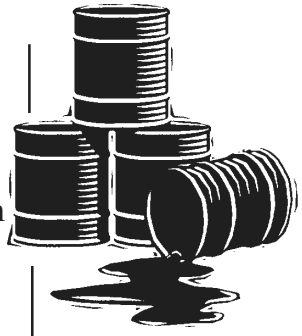
Nonpoint pollution - Pollution that cannot be traced to a specific point because it comes from many individual places or a widespread area (e.g., urban and agricultural runoff).

Nymph - The young of an insect that undergoes incomplete metamorphosis, differing from the adult primarily in size and structural proportions (i.e. wings).

Organism - A living thing. Examples include plants and animals.

pH - Potential of hydrogen. A measure that indicates the relative acidity or alkalinity of a substance. The pH scale is a logarithmic scale ranging from 1 (most acidic) to 14 (most basic), with a pH of 7 being neutral.

Photosynthesis - A chemical process carried on by green plants in which cells containing chlorophyll use light energy to produce glucose (a plant food) from carbon dioxide and water; oxygen is a by-product.



Point pollution - Pollution that can be traced to a single point source, such as a pipe or culvert (e.g., industrial and wastewater treatment plant discharges).

Pollution - A human-caused change in the physical, chemical or biological conditions of the environment that creates an undesirable effect on living things.

Precipitation - Water falling in a liquid or solid state from the atmosphere to the Earth. Examples are rain, snow, sleet and hail.

Producer - An organism that makes its own food. For example, all green plants are producers that make food through photosynthesis.

Pupa - The stage in the metamorphosis of an insect that comes after the larval stage and before the adult stage. The pupa is usually enclosed in a hardened case or cocoon.

River basin - The watershed of an entire river. It encompasses the many smaller watersheds of the river's tributaries or branches.

Runoff - Rain, melted snow and other materials that drain or flow off surfaces such as city streets, roofs, suburban lawns and agricultural land.

Sediment - Deposits of soil or organic matter that were suspended in water and then settled to the bottom. It is often deposited in the water by runoff.

Septic system - A domestic wastewater treatment system into which wastes are piped directly from the home into the ground. It consists of a septic tank and drainfield. Wastewater is exposed to bacteria that decompose the organic waste. Dead bacteria and sediment settle to the bottom of the tank, and treated effluent flows out into the ground through drainage pipes.

Sewage - Liquid and solid waste mixed with water.

Silt - A sedimentary material consisting of fine mineral particles intermediate in size between sand and clay.

Soil - A collection of organic and inorganic particles, mainly composed of clay, silt, sand and gravel.

- clay - less than 1/256 of a millimeter (mm) in diameter
- silt - between 1/256 and 1/16 of a mm in diameter
- sand - between 1/16 and 2 mm in diameter
- gravel - more than 2 mm in diameter

Species - The taxonomic category following genus that consists of similar organisms that can mate and produce fertile offspring.

Succession - The gradual replacement of one natural community by another.

Taxonomy - The branch of biology dealing with classifying organisms into naturally related groups based on some common factor.

Thermal stratification - The process during which waters of different temperatures form separate layers in a body of water with the lighter, warmer water floating on top of the denser, cooler water.

Tributary - A stream or river flowing into a larger stream, river or lake. For example, in the park lake watershed, Powder Spring Branch is a tributary of Norwood Creek.

Volume - A quantity, bulk, mass or amount. The amount of space occupied in three dimensions.

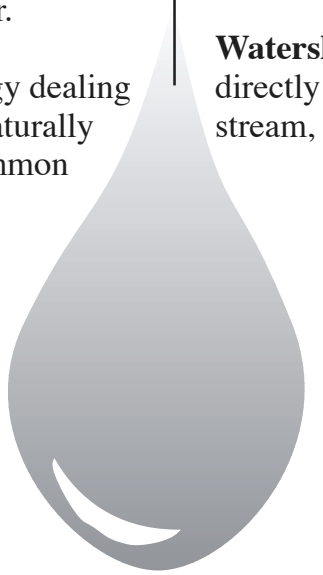
Wastewater treatment plant - A facility where household, business and industrial sewage are treated to remove harmful bacteria and chemicals.

Water - A transparent, odorless, tasteless liquid compound of hydrogen and oxygen (H_20) that occurs on the Earth's surface as oceans, lakes, rivers, etc.

Water cycle - The path water takes through its various states – vapor, liquid and solid – as it moves throughout the Earth's systems (oceans, atmosphere, groundwater, streams, etc.)

Water quality - A way of determining or measuring certain characteristics of water.

Watershed - The total land area that drains directly or indirectly into a particular stream, river or lake.



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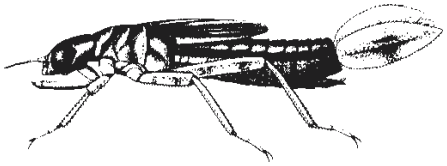

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SCHEDULING WORKSHEET

For office use only:
Date request received_____ Request received by_____

l) Name of group (school) _____

2) Contact person _____ _____
name phone (work) (home)

_____
address

3) Day/date/time of requested program _____

4) Program desired and program length _____

5) Meeting place _____

6) Time of arrival at park _____ Time of departure from park _____

7) Number of students _____ Age range (grade) _____

8) Number of chaperones _____

9) Areas of special emphasis _____

10) Special considerations of group (e.g. allergies, health concerns, physical limitations)_____
_____

11) Have you or your group participated in park programs before? If yes, please indicate previous programs attended: _____
_____

If not, we will mail the contact person an Educator's Guide.

12) Are parental permission forms required? _____ If yes, please use the Parental Permission Form on page 8.2.

I, _____, have read the entire Environmental Education Learning Experience and understand and agree to all the conditions within it.

Return to: Lake Norman State Park Fax: (704) 528-5623
159 Inland Sea Lane
Troutman, NC 28166 - 9620

PARENTAL PERMISSION FORM

Dear Parent:

Your child will soon be involved in an exciting learning adventure – an Environmental Education Learning Experience at _____. Studies have shown that "hands-on" learning programs improve children's attitudes and performances in a broad range of school subjects.

In order to make your child's visit to "nature's classroom" as safe as possible, we ask that you provide the following information and sign at the bottom. Please note that insects, poison ivy and other potential risks are a natural part of any outdoor setting. We advise that children bring appropriate clothing (long pants, rain gear, sturdy shoes) for their planned activities.

Child's name _____

Does your child:

- Have an allergy to bee stings or insect bites?_____
  If so, please have your child bring his/her medication, and stress that he/she, or the group leader, is able to administer it.

- Have other allergies? _____

- Have any other health problems we should be aware of?_____
  _____

- In case of an emergency, I give permission for my child to be treated by the attending physician. I understand that I would be notified as soon as possible.

_____ _____
Parent's signature date

Parent's name _____ Home phone _____
(please print) Work phone _____

Family Physician's name _____ phone _____

Alternate Emergency Contact

Name_____ phone _____

NORTH CAROLINA PARKS & RECREATION
PROGRAM EVALUATION

Please take a few moments to evaluate the program(s) you received. This will help us improve our service to you in the future.

1. Program title(s) _____ Date _____
   Program leader(s) _____

2. What part of the program(s) did you find the *most* interesting and useful? _____
_____

3. What part(s) did you find the *least* interesting and useful?_____
_____

4. What can we do to improve the program(s)?_____
_____
_____

5. General comments _____
_____
_____
_____

LEADERS OF SCHOOL GROUPS AND OTHER ORGANIZED YOUTH GROUPS
PLEASE ANSWER THESE ADDITIONAL QUESTIONS:

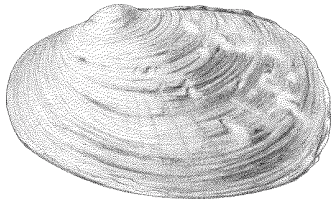
6. Group (school) name _____

7. Did the program(s) meet the stated objectives or curriculum needs? _____
   If not, why? _____

Please return the completed form to park staff. Thank you.

Lake Norman State Park
159 Inland Sea Lane
Troutman, NC 28166 - 9620
Fax: (704) 528-5623

Notes



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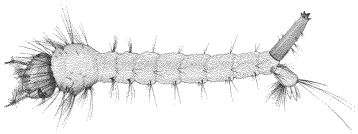

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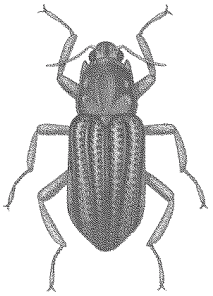

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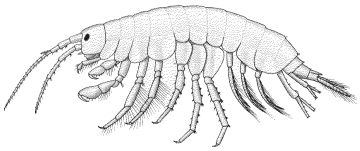

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